SCIENCE EDUCATION

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VOLUME 30 — MARCH, 1946 — NUMBER 2

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(The Contents of SCIENCE EDUCATION are indexed in the Education Index)

INTRODUCING THE CONTRIBUTORS

When Science and Religion Meet is a noted scientist's answer to the most important and crucial problem that has ever faced mankind. Has mankind the intelligence and goodwill to solve the problems confronting him at the opening of a new era—*the Atomic Age?* Dr. Kirtley F. Mather, Professor of Geology at Harvard University and one of America's most noted geologists, has given much thought to the problems of religion and science. He is author of numerous technical papers and books in geology as well as author of the more popular books, *Old Mother Earth, Sons of the Earth,* and *Enough and to Spare.* He is chairman of the Education Committee of the Scientific Book Club, a member of the Executive Committee of the American Association for the Advancement of Science, and Book Review Editor for the magazine *American Scientist.*

Few problems relating to the methods of teaching science have evoked more discussion or have been the basis of so much classroom experimentation as have the related problems of individual pupil laboratory work and demonstration experiments. This was especially true of the decade beginning about 1920. Dr. Harry A. Cunningham presents an excellent analysis of the research work that has been done in this field. He is Professor of Biology and Head of the Department of Biology at Kent State University, Kent, Ohio. He is the author of numerous articles and several books.

The other contributors have recently had articles in SCIENCE EDUCATION and were introduced at that time: Dr. Smith, February, 1946; Lt. Keeslar, December, 1945; and Dr. Pruitt, February, 1946.

SCIENCE EDUCATION

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WHEN SCIENCE AND RELIGION MEET*

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ON July 16, 1945, civilization crossed the threshold into the age of atomic energy. Very few persons knew it at the time. They, of course, were the scientists, technicians, and Army engineers, who were observing the first test of the first full-scale atomic bomb in the Alamagorda Bombing Range near Los Alamos, New Mexico. Within a few weeks, however, all the world knew about this spectacular event. By that time, Hiroshima and Nagasaki had been practically annihilated and Japan had hurriedly surrendered to the victorious Allies.

Since then, most of us have been pondering very carefully the meaning of this tremendous event. It is, obviously, an ultimate in the annals of science as a demonstration of the validity of the scientific method, and of the results of application of pure theory to practical affairs. More than this, it is the ultimate in the organization of large numbers of individuals, the most splendid example of cooperation among men that has ever been given to us. All these are involved in the Manhattan Project and the achievement of its objective—the manufacture of the most terrible and most terrifying military weapon known to man. But beyond these thoughts we have been wondering what it means in our own lives, in the lives of those who are to come after us—what it means in the life of our nation.

One idea is now absolutely clear. From the welter of comments and orations, of statements by politicians and announcements from scientific sources, there emerges at least one fundamental principle: This new weapon is of such a nature that there is nothing that we can do to prevent any one of a dozen other nations, if they set their scientists and engineers to the task, from being able, within a very few years—3, 4, or 5 years—to do to us what we have demonstrated we can do to them.

If that is a correct conclusion—and I, for one, believe it to be true—then we have a new comprehension of the meaning of interdependence in our one world.

We had been thinking and talking about interdependence in terms of our ability to import tin from Malaya, rubber from the Netherlands East Indies, coffee from Brazil, or nickel from Canada. We had been talking and thinking about interdependence in terms of our ability to export and sell our sewing machines and vacuum cleaners, our radios and automobiles, our voice amplifying systems and our zippers to the citizens of Bolivia or Belgium, Turkestan or Indo-China. Now comes a new comprehension of what interdependence in the modern world really means.

* An address delivered at a convocation at the University of Illinois on January 22, 1946.

If it be true that there is no adequate military defense against atomic weapons and that there is no means whereby we can prevent other nations from gaining the ability to manufacture them, then it follows that our security, our prosperity, indeed, our very existence, depend just as much upon the intelligence and good will of the governments and peoples of foreign nations as they do upon our own wisdom and good intentions.

That is a sobering thought, especially to those of us who know how slowly the forces of education and religion have made progress in the last two thousand years. It is a sobering thought, especially to those of us who are realistic in our outlook upon life as well as idealistic in our painting of goals and descriptions of objectives. We know how many there are in the world who have warped intelligence and are possessed or motivated by evil intent. And so we are very much worried, and well may we be worried.

I hasten, however, to tell you that there are methods whereby the use of atomic weapons may be controlled. Those methods involve international cooperation. They cannot be operated by any one nation. But the distribution of uranium throughout the crust of the earth, and the nature of the processes involved in manufacturing weapons powered by the energy released on nuclear fission, are such that it is perfectly practical for an international organization to make absolutely certain that no atomic bombs can ever be manufactured anywhere in the world in secret. There is a method of control. That, of course, is something that must be put into immediate operation.

At the same time, we must keep in mind the long range objectives: increase intelligence and improve the dynamic of good will throughout the entire world. Intelligence and good will! these and these alone will in the long run save mankind from self-destruction.

Anyone who comprehends something of the nature of energy derived from nuclear fission, who knows even a little about the possibilities of jet propulsion and rocket bombs, who is aware of the transformation in methods of transportation and communication that has been perfected in World War II—any such person, if he "thinks without confusion clearly," must come to a new appreciation of the truth of an ancient scriptural statement: Not by might, nor by power, but by My Spirit, saith the Lord of hosts. Intelligence and good will—these and these alone represent the spirit of the Lord of hosts, and give some hope of future security and comfort, and, presumably, happiness for mankind.

Intelligence—why, that's the very heart of science. Good will—that's the very essence of religion. And if, quite naturally, we join together by the word "and" those two words "intelligence" and "good will" we are unconsciously announcing that science and religion have met.

The meeting is not new. Neither is the atomic bomb new. All through the ages since men first began to think, individuals here and there have discovered ways and means of increasing their efficiency. New methods of providing energy with which to do the work of the world have followed each other in regular sequence. Atomic energy is simply the natural projection of the past into the present.

As of old, the burning question of our day is: "What will mankind do with the new power that science is placing in the hands of men?" Scientists *have* started something that they can't finish as they succeeded in their research and their engineering tactics under the Manhattan Project, but they have done so repeatedly in ages past. The something which they can't finish is in the area of human relationships, the area in which the voice of religion frequently asserts itself, and often should be heard.

What will we do with the new power?

It is an age-old question. Always throughout history there have been some who said: " It will be right to do this with the new power; it would be wrong to do that." Even so today. So far as science is concerned—strictly speaking—it would be perfectly feasible for a few individuals to use this new power, just as in the past a few individuals have attempted to use the power that in their day was new, for their own selfish purposes, beating down other men, using other human beings as tools, or pawns, to contribute to their own self-centered desires. Or, from the point of view of science, it would be just as feasible for all men to profit by the application of this new power, using it for the welfare of every individual. The materials are the same, the methods are the same, the objectives are very different.

Intelligence is really not enough. Most of you probably have leaped instantly to your decision and have said it would be far better to use power for the welfare of everybody than to concentrate its beneficial results in the hands of just a few at the expense of the many. But you made that decision because, whether you knew it or not, you were listening to the voice of religion. So far as pure intelligence is concerned, there is no truly rational, absolutely reliable decision that can be made. It is only when you consider the rights and the desires of other folks than yourselves, it is only when you appreciate the fact that you are but one member of a great world-wide family, it is only when you expand the horizon of your sympathetic consideration for other people until it embraces all mankind that you have a basis for what I agree with you is the right decision.

Decisions of that sort, selection of what is right from what is wrong, these have been made from time immemorial. Science asks the questions, " How many?" " How heavy?" " How swift in motion?" Religion asks the questions, " How good?" " How lovely?" " How worthy of our loyal devotion?" Between these two categories of questions there is a very important distinction, and now at last we bring them together—science *and* religion, intelligence *and* good will.

I say this is not a new junction nor a new problem. It is—nobody knows how old. Go way back into the Book of Genesis and you find that that same problem was being faced in the centuries far before the dawn of the Christian era. Recall the second of the two creation stories in the Book of Genesis—the one in which there is the reference to the Garden and the Tree of Knowledge of Good and Evil, and the Tree of Life.

Obviously, that is an allegory. There is not and never could be any such reality in the physical world as a " Tree of Knowledge of Good and Evil." It's a figure of speech. Then, even as today, artists, authors, poets, used figures of speech in order to drive home, to embed deeply and permanently, if possible, some great, important, eternal truth.

You recall in that second creation story, how the fruit of the Tree of Knowledge of Good and Evil was eaten by the man and the woman. That's an eternal truth. Somewhere back in our ancestral lineage there was an individual who for the first time said, " It is right to do this. It would be wrong to do that." And I presume it *was* a woman who first partook of the fruit of the Tree of Knowledge of Good and Evil and then taught us poor male members of the human family what she had glimpsed concerning moral law. I am just as proud of that first ancestor of mine who first was aware of moral law in her, or his, universe, as I am of that other early ancestor of mine who first flaked a flint to a cutting edge and, with the intelligence of science, made himself more efficient, provided himself with a tool with which he could work more skillfully and more swiftly than otherwise could have been possible.

I know, of course, that there are some who look down upon that first man and first woman for having sinned in such an awful way. It is most curious to me how people have misinterpreted, or have been led to misinterpret, what to my mind is a most beautiful bit of eternal truth. If you want to know about what happened in that poetic allegory, don't read what other folks have written about it. Go straight to the source itself—Genesis 2 and 3. And over toward the very last verses of Genesis 3, you will find something that ought at least to cause some curiosity in your mind.

" Now therefore, said Jehovah God, this man, having stretched forth his hand to partake of the fruit of the Tree of Knowledge of Good and Evil, has become like one of us." Those are the words. Read it and see. Many gods—each for a nation or a tribe, I suppose. " Now, therefore, lest he stretch forth his hand also and partake of the fruit of the Tree of Life and live forever, I will send him forth to till the ground whence he was taken." Therefore, to guard the way to the Tree of Life, the cherubim were set at the gates of the Garden with their flaming swords flashing every which way.

That was the ancient pre-mosaic concept of what the administration of our universe had in store for men. That was their concept of the possibilities of human attainment, and the relationship between the gods whom they worshipped and the men themselves.

Over against that, you and I hear an echo from the Galileean hillsides. " I came that ye might have life and have it more abundantly." No guarding of the way to the Tree of Life by cherubim with flaming sword. Instead, a highway to the Tree of Life, the gates wide open. " Whosoever will may come." " Be ye therefore also perfect, even as your Heavenly Father is perfect." No fear that man would achieve a likeness to God. Instead, a directive loud and clear and unmistakable: Be just as God-like as you possibly can.

Religion has advanced since the days when those portions of the Book of Genesis were being inscribed upon the ancient tablets and the time-worn parchment. We sometimes boast about the remarkable progress made by the scientists in their search for truth. It is paralleled by the great progress made by men of vision, the prophets and the seers, in their search for a comprehension of the nature of our universe and an understanding of the moral law. Religion, like science, is a vital, living, growing, and therefore changing, reality in our world.

It would be just as false to true religion to enclose it in the crustations of the past and leave it there as it would be false to science to refuse to accept the modern description of the composition of an atom, and cling instead to the concepts of the nature of atoms that were orthodox fifty years ago.

Science and religion have much in common. They also have certain distinctive characteristics that permit one to place ideas, opinions, descriptions, and missions in one or other of the two categories. Perhaps the most important of these distinctions in the past is going to be obliterated in the future. There was a time when the scientists devoted all their attention to the world of physical reality around about them. In that world, they observed the apparently automatic motions of the heavenly bodies. They observed the inflexible operations of the laws of cause and effect. They detected the mechanical arrangements that we learn about in our courses in physics and chemistry, the marvelous arithmetical alchemy of nature whereby numbers from " 1 " to " 94 " may be used to designate the elements of the earth crust, including, of course, No. 93, neptunium, and No. 94, plutonium, the latest of the elements to be recognized as such in our laboratories. Observing so

much that seemed mechanical in the operations of inanimate nature, it was easy to infer that the universe as a whole is a giant mechanism. But gradually the scientists began to focus their attention upon the behavior, as well as nature, of animals and plants, and last of all they came to study human nature.

Much of what we refer to in our everyday speech as human nature is that which we share with other animals. Sometimes the biologist is tempted to conclude that human nature is only animal nature—nothing more. But when you begin to investigate the behavior of human beings, you discover that there are certain characteristics which man does not share with any other creatures, differences in degree of such importance that they cannot be overlooked if indeed they are not actually differences in kind. When the dog on the hillside turns from his baying at the moon to construct a system of astronomy, you would be justified in putting the dog and the man in the same category. And when the cow lifts her head from munching the grass to admire the view at sunset, you might be justified in concluding that man is just like all other animals.

Concentrate your attention, just for the fun of it some time, upon those characteristics of human nature that are not shared by any other creatures, and you will find that they are of utmost importance now.

Until lately, all such characteristics of mankind were believed to be beyond the reach of natural science. Therefore, they were in the sacred precincts of religion. But now, if it be true that only intelligence and good will can save mankind from self-destruction, then we would do well to investigate the sources of good will, the manifestations of that attitude toward others. We had better investigate the ways and means of increasing that spiritual power in the everyday life of men and women.

Already we have some hints. Most of them have been derived from the halls of religion. We are not the first, in this atomic age, to understand the real nature of interdependence. Down through the ages, in many times, at many places, there were individuals of superb intelligence for their time, and superior good will for all time, who understood the facts of life in an interdependent world. Now, at last, those facts are thrown into our faces with extreme violence. The vision of what interdependence really means comes with blazing clarity like the flash of an exploding atomic bomb.

I do not believe that the method of making people good by scaring them has ever proved very successful. I am quite sure that frightening people half out of their skins is not the best way to transform them into something more nearly like the creative, administrative spirit, that pervades our universe. Nevertheless, it may well be that under the impetus given by these latest achievements of science, men will make more progress toward the world of brotherliness, kindliness, sympathy and good will in the next ten or twenty years than has been made in all the preceding thousands of years. It might work that way. It will prove so only if all the resources of both science and religion are mobilized for the task.

We need superior intelligence. Even more do we need a widening spread and a deepening hold of the Christian motive of good will toward all men.

Today, as never before, there is an opportunity for the scientist and the religionist to work together. As a matter of fact, I reject the dichotomy between the two. None of us are one hundred per cent either. All of us—even he who claims to be a cynical atheist, even he who rejects all of the findings of modern science which he believes are contrary to some literal interpretation of the Bible, and all the great majority of us in between these two ex-

tremes—display, in varying ratios, a mixture of the characteristics of the scientist and the characteristics of the theologian. And that is well. It is as it should be.

It is the function of science to discover truth. But for what purpose? Why should men seek truth? The answers are various. Religion has one answer. Seek truth, not for truth's sake, but for the sake of human welfare. Extend and expand your research, not just to satisfy a natural curiosity and certainly not just to bring rewards of acclaim or wealth or position to you; extend and expand your research in order that men here, there, and everywhere may be better because of what you have done.

And how shall we decide what is better, what is worse? Somebody, and preferably each for his own self, has to provide a measuring standard. How do you know which is good and which is bad? An age-old question. A never completely solved problem. You may perhaps assume that an answer that should be tried, a pretty fair working hypothesis, would be to measure badness and goodness in the light of what is the best possible concept of the nature of the administration of our universe. That is, be like God. How do you find out what God is like?

There are many paths that lead toward—if not to—the spot where that question may be answered, and each must choose his own path. I, for one, have no quarrel with a person who takes a different path from mine. My quarrel is only with the person who makes no effort to find or pursue any path at all.

There are clues that the scientist may provide for the man of religion. I find such clues in the record of geologic life development—the fossils in the rocks. We have been able to reconstruct at least the outlines of a series of moving pictures of the life of past ages. We know something about the lines of evolutionary development, generation to generation, epoch to epoch. We have observed that along the path of life, many have marched in the great procession of the living, and some, although they were for a time at the head of the procession, came to a stopping place. Sometimes off into a blind alley, sometimes right in the middle of the great highway, they faltered, fell, and became extinct. We would like to know what has determined success or failure along that pathway, because we today are marching at the head of the procession. The fact that we are there, of course does not guarantee that we shall continue to hold that position for an indefinitely long time in the future. Therefore, it might be well for us to know something of the regulations that have decreed life or death for other leaders in the past.

As we survey that procession, we get a glimpse of the nature of the creative power displayed in the events and creatures themselves. Here I give you very briefly some of my own interpretations. Take them for whatever you may think them to be worth. No authority of any sort should be attributed to them; they are just the suggestions of one very ordinary individual.

As I have looked at this record of the past, it has seemed to me that the creative power was certainly not a blindly mechanical machine. Instead, I find in that expression of the creative power much that I recognize as akin to human beings themselves. Over and over again, obstacles were met by that procession along the path of life. Every time, somewhere, somehow, some group of individuals advanced past the obstacles, going over, under, around, or through, now one way, now another, trying many ways and failing in many of them. But always, somewhere, some group succeeded. It's the well-known method of the intelligent man or woman. "Try it and see." "If at first you don't succeed, try, try again." "If this way is blocked, perhaps you can go around some other way." Almost always

the raw material with which the experiments were about to be made was apparently inadequate. Consider producing a biped animal who now and then lifts his face towards the stars and asks the question, " Why? "; who now and then reaches out a hand of sympathy and love to a less fortunate member of that species; who even occasionally is ready to lay down his life, if need be, for a cause or for a friend, or for an ideal, intangible though the ideal is when approached from the point of view of science. Imagine making that sort of creature out of the animals who bow like phantoms behind us. Who could have hoped that from the fishes of the Devonian period or the reptiles of the African Triassic, or even from the genus Notharctus and his kind in the early Tertiary, such a product could have been achieved. The creative power took whatever materials were at hand and made the most of them.

From such a survey, one gets a definite sense of sympathetic relationship between one's self and the infinite creative power. You somehow belong to that sort of an administration. No wonder that you find on occasion the other path is open—the path of immediate and direct experience in which spirit with spirit may meet. No man of science who is really worthy of the name, aware of the frequency with which that which seemed impossible yesterday is accomplished today, no man of science acquainted with our modern concept of the nature and structure of matter and energy could for a moment forbid the attempt to make that intimate contact of spirit with spirit. Indeed, as we ponder the urgency of the present crisis, as we consider the potency of these new forces now available for human use, as we observe how important it is that the right decisions be made concerning the use to which mankind will put the power placed in his hands by science, we are very humble. We crave all the support that we can secure by our mutuality, in approaching the problem, by our opening of ourselves to any draft of spiritual power that may be available in the vast resources of our far-flung universe.

We accustom ourselves to the close union—intelligence and good will, science and religion. We are well aware of the possibilities of the future. We know that we are still on trial as inhabitants of this earth, that we are even now being weighed in the balances. Is our life such as to justify our continuance as inhabitants of the earth? Are we behaving in accordance with the regulations of our universe? Do the sum total of the forces in our environment give approval to the ways in which we are living? These are the burning questions as we go forward, hopefully, albeit somewhat fearfully, courageously albeit well aware of the grave dangers, prayerfully, albeit confident that within human nature itself there are resources which, when liberated and used to the full, are competent to keep mankind at the head of the forward-marching procession.

We know the possibilities of failure. We strive for success. As Edna St. Vincent Millay put it some years ago, in her poem " Renaissance ":

> The world stands out on either side
> No wider than the heart is wide;
> Above the world is arched the sky
> No higher than the soul is high.
>
> The heart can push the sea and land
> Farther away on either hand;
> The soul can split the sky in two
> And let the face of God shine through.
>
> But East and West will pinch the heart
> That cannot keep them pushed apart,
> And he whose soul is flat, the sky
> Will cave in on him by and by.

LECTURE DEMONSTRATION VERSUS INDIVIDUAL LABORATORY METHOD IN SCIENCE TEACHING —A SUMMARY

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Introductory remarks. In this article we are to look back over a period of a little more than twenty-five years and see what has happened, in the field of research, to one problem of science teaching, namely, the problem of lecture demonstration versus individual laboratory work. Perhaps it will be well to recall a few of the factors which were present in the science teaching situation at the time when intense interest in this problem first arose. The end of the nineteenth century and the beginning of the twentieth found the schools faced with the necessity of teaching large numbers of students, often in large classes. As the schools grew in size and their financial burdens increased, a criticism arose concerning the cost of science instruction—the cost of equipment, supplies, service facilities, furniture, and specialized rooms. Then, too, there had been a tendency in some schools—particularly the larger ones—to simplify the complex administrative problems of making programs by scheduling all subjects for uniform single periods and eliminating double periods for laboratory work. There were also contributing factors from the field of Education. A great enthusiasm for the development of a Science of Education was abroad in the land.

Were the experimenters, and agencies to which the research work on this problem was submitted, dependable? These studies were submitted and accepted in eighteen cases for Master's theses and in six cases for Doctor's theses. The institutions accepting such research were and the number of theses accepted by each was, as follows: University of Chicago, four [21, 23, 28, 33] (Anibal's two studies counted as one publication); Columbia University, two [29, 36] (Horton's three studies counted as one publication); Indiana University, one [30]; Temple University, one [32]; University of Pennsylvania, one [34]; University of Southern California, two [38, 43]; New York University, three [40, 46, 52]; George Peabody College for Teachers, one [41]; University of Wisconsin, one [42]; University of Washington, one [44]; University of Kentucky, one [47]; State College of Washington, one [48]; University of Kansas, one [49]; College of the City of New York, two [50, 51]; and The University of Texas, one [31]. The writer does not know the name of the institution to which Mayman's study was submitted for a Doctor's thesis.

The studies which, so far as the writer knows, were not used as thesis material were published in professional periodicals as follows: Journal of Educational Psychology, one [20]; School Science and Mathematics, four [24, 25, 27, 45]; School Review, one [22]; Journal of Educational Research, three [26, 35, 37]; and Pennsylvania School Journal, one [39]. The writer of a Master's or a Doctor's thesis has the benefit of an adviser or a committee and must stand an examination over his work. The work presented in these studies has been accepted by a fairly broad sampling of good educational institutions over the country.

The problem. The variable that seems to have been common to all the thirty-seven studies was in the field of method and pertained to the manner of getting the laboratory experiences in science. Under one method the pupils gained their experiences by observing experiments or laboratory exercises that were set up and

manipulated by some one—generally the science instructor. Under the other method the pupils themselves, performed experiments and laboratory exercises with, made observations on, and manipulated materials.

Have the problems of these studies been definitely and precisely stated at the beginning of each undertaking? Not all have been so stated. A beautiful example of this fault was demonstrated by the writer himself [21] when he defined his problem as follows: "To determine whether the individual experience of a pupil in laboratory work pays for the extra time and trouble; or will better results be achieved more economically from the lecture demonstration method; or will better results be achieved by individual laboratory work under some conditions and by the lecture demonstration method under other conditions?" A much better statement, from the standpoint of definiteness and preciseness, of a problem was the following one by Scott [44]: "The purpose of the present experiment was to determine the effect produced by the demonstration and the laboratory methods on the amount retained as shown by the gain in points made on a standardized general science test. Normal teaching conditions were maintained as far as possible in each division so that the results obtained would be such as would be gotten if the class were being taught by that particular method but not for the purpose of an experiment."

Have the separate specific problems or outcomes of the various studies been definitely stated at the beginning of each report? The relative effects of the two methods on the following outcomes have been considered by some of the studies: information—immediate and delayed; interest of pupils; economy of time; laboratory resourcefulness; scientific thinking; individual differences; economy of money, equipment, supplies, service facilities, furniture, and rooms; traits of pupils; and ability to manipulate laboratory apparatus. Some studies dealt with one or relatively few of these outcomes; others considered several. Instances were found where items mentioned in the problem statement at the beginning of the report were not mentioned in the conclusion; and where items mentioned in the conclusion were not listed in the statement of the problem or problems at the beginning of the study.

Were variables, that should have been held constant, allowed in the experimental situation? In some of the studies such factors have been noticed and the data bearing on them have been considered in the evaluation of the general results. Evidence has been presented which indicates that the general results were possibly influenced, in some instances, by such factors as complexity of experiments done and apparatus used; length of the period over which an experiment necessarily extended; size of the laboratory apparatus; closeness of view necessary in observing the results of an experiment; sex of pupils; and the time spent upon an experiment by one method as compared to the time spent on the same experiment by the other method.

Other factors in the experimental situation which were mentioned by some experimenters and which, if allowed to vary within an experiment, might have influenced the general results were: age of pupils; year in school; bright or slow pupils; previous science studied; time of day; temperature conditions; previous mental work on the day of experiment; with or without detailed directions; different or same teacher for control and experimental groups; and who performed the demonstrations—the teacher, or one or more of the pupils.

One variable that was present in the experimental situation of at least fifteen of the studies and probably in many more—possibly in all of them except one—was the time taken to perform an experiment by one method as compared to the time taken by the other method. It is true, of course, that this factor was considered as one of the important outcomes in many of

the studies. It is interesting to speculate as to the possible influence this variation in time may have had on some of the other outcomes, such as, information, understanding of principles, and the ability to think in terms of the science being studied. Here, it would seem, was a confusion which resulted because of the introduction of one element as a variable in the experimental situation at the same time that it was being considered as an important outcome. The only study noted by the writer in which the report stated that the time element was held constant under both methods was the first study by Walter [33]. And in this study Walter introduced drill as a variable in the field of method in place of the time variable in the experimental situation. Other specific instances of variables in the experimental situations could be cited. In many instances there is no evidence in the reports which would remove all doubts that many such variables were not present and it is probably right for us to infer that many such did exist.

On the other hand there was one point in the teaching situation where almost every one gave some attention to the elimination of a possible variable. I refer to the rather vague feeling on the part of all that the mental situation—ability or capacity of pupils—at the beginning of a study should be approximately the same for the control group on the one hand and the experimental group on the other. This brings up the matter of equating the experimental and control groups of pupils in a study or equating the two individuals of each of several pairs. In twenty-four cases equating was done as a group; in four, the equating was done on the basis of pairs—an individual from the experimental group being paired with one of like mental condition from the control group; and in the remainder—nine studies—no formal equating of groups or pairs was done. Two of the nine depended upon the rotation method of performing the experiments for satisfactory equating. The remaining seven depended either expressly or by implication upon random sampling for any equating that might have happened.

Different ideas have prevailed as to the most suitable instruments for doing this equating. The majority—twenty-two—took the point of view that equivalence of I.Q. would likely mean equivalence [17] with respect to other traits which were important, particularly if such data were checked by results from one or more other instruments, such as previous school grades; previous grades in the subject in which the study was being conducted; age of pupils; year in school; reading ability; standard test in subject; sex of pupils; informal test in subject; grades in prerequisites; and scores on Regents Examinations. Eleven of twenty-two used the I.Q. alone as an equating instrument and eleven used the I.Q. plus one or more of the other instruments listed above. Each of six studies in which the I.Q. was not considered as an equating instrument used one or more of the above instruments. Those few experimenters who thought that equivalence should be sought in terms of the thing in which a change in the pupils was expected [2] used one or more of the following equating instruments: previous grades in the subject in which the study was being conducted: standard tests in the subject; informal tests in the subject; laboratory grades; scores on Regents Examinations; and scores on a pretest. In the few instances where a pretest was used the same test, or an equivalent form, was administered after the teaching had been done and the differences between the scores made on the pretest and the scores made on the same test, or an equivalent form, after teaching were used as the data for the studies.

Were variables, that should have been held constant, permitted in the methods of teaching used? An attempt was made in most studies, although not in all, to keep all factors constant within each study with the exception of the one variable allowed.

Variations in method were rather frequent and marked from study to study. The writer noted such variations from study to study as: with or without written report; oral or written instructions; with or without drill; with or without notebooks; with or without detailed instructions; with or without notes made in the laboratory; laboratory work done by pupils, individually or in groups of twos, threes, or fours; demonstrations presented by one or more individuals during the laboratory period or demonstrations set up beforehand like a museum-demonstration with labels, questions, and notes attached; degree of rigidness of control during the laboratory period; experimental and control groups conducted by the same or different teachers; and methods used in conducting the groups on days other than laboratory days. Variation of the last named factor occurred in some cases within individual studies. In most cases the demonstrations were done by the experimenter. But, in one study—the one by Van Horne [43]—a few of the demonstrations were done by the best student workers, and, in another—the study by Boretz [46]—pupils did all of the demonstrations for the rest of the class.

In the discussions concerning these studies, questions have arisen as to: (1) whether the laboratory periods should have been formal or informal; and (2) whether the control and experimental groups should have been conducted by the same or by different persons. In some of the studies the methods used during the laboratory periods were strictly controlled in the attempt to eliminate variables to the point of making the laboratory period very unrepresentative of the procedures that would normally be followed during such an exercise. In others the conduct of the laboratory sessions was more informal—more like the procedures that are ordinarily used during such activities.

In the critical writings concerning these studies both points of view have been upheld but the latter method—that approaching a normal teaching situation—has been most often approved or, it might be better to say, the former procedure has been most often criticised [2, 16, 17, 14]. At least one voice has been raised in print, in favor of the more rigidly controlled technique [6]. Those who have favored the more rigid control, while freely admitting that it results in a very nontypical teaching situation, have thought that such a procedure is necessary if the accepted rules which are supposed to be important in scientific problem solving are to be followed and if the necessary safeguards [10] are to be thrown around each step of the process.

Data were obtained wholly or in part by teachers other than the experimenter in the studies by Carpenter [29], Horton [36], Payne [47], Dyer [34], Shore [41], and White [52]. But, in most cases the experimenter carried on the entire enterprise and handled both the demonstration work and the individual laboratory work. One critic, at least, insists that it would have been better to have had the demonstration group taught by a teacher that was especially good in demonstration and the laboratory group taught by another teacher that was equally good in conducting individual laboratory work [17]. What one thinks about this point depends, to a great extent, upon the point of view accepted about the preceding problem. If a certain kind of teacher is assumed to be a part of the demonstration method and a different kind of teacher a part of the individual laboratory method, then the experimental group and the control group should be conducted by different teachers if a teacher cannot be obtained that is equally good in, and equally enthusiastic for, either method. Here again we have the problem, similar in some ways to the preceding one about time, of deciding whether the teacher should be considered a factor in the teaching situation and therefore held constant; or whether he should be considered a factor in the method—be

thought of as a part of the particular method being used and therefore a part of the one variable allowed.

What kind of data were obtained in these studies and how were they obtained? The data were obtained mostly by means of written work—generally written tests. In two cases tests were devised to measure the ability of the student to manipulate laboratory apparatus. The questionnaire was used in a few studies to determine what the pupils though of the two methods. Six enterprises used standardized science tests. In seven undertakings the data were obtained from either the essay test or from write-ups of the laborator experiments--these papers being analyzed and graded as objectively as possible. A majority of the experimenters used home-made objective tests to determine the degree of progress of the pupils under each of the methods toward the outcomes aimed at in the particular studies. These researches have been criticised as a group because the tests used were, for the most part, verbal and measured "mere information" [11, 14, 16, 17]. Present-day educational writers do not seem to have much use for the word "information." When this word is used there is a tendency to whisper it; to precede it by such words as "mere" or "merely"; and to follow it immediately by minimizing phrases and sentences.

Were the data obtained under a variety of conditions? While the information telling just where these studies were performed is not complete, sufficient is known to enable us to say that they have been widely scattered over the entire United States. Carpenter [29] alone secured data from fourteen different states. Payne's study [47] was conducted in four different colleges. Shore [41] obtained data from seven schools in Tennessee and one in Georgia. We do know that five of the others were done in New York; one in Florida; five in Illinois; two in Missouri; one in Montana; one in Texas; two in Pennsylvania; one in Arizona; one in Idaho; and one in Kansas. The studies reported extend in time from 1912 to 1943.

Of the thirty-seven productions reviewed, one was done in the grades; thirty-three in the junior or senior high school; and three were done in college. The one study in the grades dealt with physical science—elementary physics [19]. Three of the undertakings have been carried on in the field of high school general science [44, 46, 50]; seven in the high school biology [21, 23, 24, 25, 27, 37, 49]; nine in high school physics [22, 26, 33, 34, 38, 41, 42, 45, 48]; and fourteen in high school chemistry [20, 28, 29, 30, 31, 32, 35, 36, 39, 40, 43]. In chemistry one reference covers three studies and another reference covers two. Of the college studies, one was in college chemistry [47]; one in college engineering [52]; and one in biology [51].

Are the data extensive? From the information at hand the writer could determine in about half of the cases the number of experiments or exercises performed in each study. The largest number of exercises found in any one study was one hundred [49] and the smallest number six [45]. The average number of exercises or experiments, in the studies which reported such data, was 20.6 per study.

While the number of pupils in the individual studies has been in many cases quite small, the total number used in all of the undertakings is rather impressive. Five hundred cases were used in the one grade study; 162 cases in the studies in high school general science; 337 cases in the studies of high school biology; 620 in the studies in high school physics; 2349 in the studies in high school chemistry; and 529 cases in the college studies—299 in Payne's study; 150 in White's; and 80 in Kahn's. The writer has been unable to determine the number of cases used in the study by Phillips [22] and in the second study by Walter [45].

There are two possible points of view to take when evaluating these productions in the light of the number of cases in-

volved and the variables, other than the one allowed, which have not been held constant from study to study. Since a great number of the individual studies had a rather small number of cases and some other shortcomings as well, it is possible to conclude that one cannot add together the findings of a number of such defective studies and come out with general conclusions which are very dependable. On the other hand, all of these researches might be considered as one large study in which, while there were admittedly many variables uncontrolled and small populations appearing in some of them, the number of cases for all of the enterprises is rather impressive and there was only one variable that constantly appeared in all, namely, the difference in the method of doing the laboratory work. Those who think that the latter point of view might have merit can maintain with some justification that, by using accepted methods of inductive reasoning—the method of agreement and the method of difference [18]—conclusions can be reached that are worthy of serious consideration in cases where there is considerable agreement in the results—such as the immediate results favorable to the lecture demonstration method for imparting science information or those favoring individual laboratory work for teaching ability in the manipulation of laboratory apparatus and in the solution of laboratory problems.

One study covered a period of two years; seven a period of one year; fourteen, one semester; one, eight weeks; one, a short period for each of two years; one, sufficient time to cover two topics—heat and mechanics—in high school physics; and one, sufficient time to cover one unit—mosses—in college biology. In the other studies the writer was not able to determine the time taken for each study.

Anibal, Cooprider, and Cunningham repeated, in approximately the same manner, their studies a second time. Since the study by Hix covered a two year period in high-school physics, it is reasonable to assume that his work the second year was an approximate repetition of that done the year before.

Were the data used in these studies valid? Did the tests used measure what they were supposed to measure? In thirty-two cases, out of the thirty-seven, the reports state that some attention was consciously given to the validity of the tests used. The ways of determining validity were: by comparison of test scores with the final grades in the course; by obtaining the opinion of competent judges; by comparing the tests with stated criteria; by comparing the test items with the course of study, the syllabus, the text, the laboratory exercises; by the correlation of the scores of different examiners; by the correlation of the test scores with the scores on the Regents Examination; and by the use of standardized tests, the validity of which had been previously determined for the subject as a whole or for certain topics of the subject. In many of the studies, evidence is lacking which would indicate that the objectives for the various laboratory exercises have been stated very specifically and the validity of the tests determined in the light of these objectives.

Were the tests used in these studies reliable? How accurately did the tests measure what they were supposed to measure? As a matter of fact the evidence concerning the reliability of the tests used is, for the most part, lacking. In not more than four studies were data given in the reports which indicated in an objective manner that the tests used were highly reliable. In the four cases which reported statistically upon reliability, three compared the odd questions against the even ones in what is called the split-half method and one compared the results obtained on two forms of the same test. On the other hand, absolute evidence which would prove that the tests were not reliable is also lacking.

How were the data handled? There has been a great improvement in the later studies in the statistics used in handling

the data. Aside from a few of the most outstanding earlier studies—the studies by Carpenter [29], Horton [36], and Knox [31] are fine examples—good, acceptable modern statistical methods were not used. Of the later studies, the ones by Pugh [39], Brasure [42], De Jarnett [49], Scott [44], Hix [48], Goldstein [50], Payne [47], Kahn [51], and White [52] are presented by statistical methods which, in all cases, would probably be classed not lower than fair and in some instances excellent. Of course no amount of elaborate statistical procedure will furnish dependable results from data which are lacking in extensiveness and accuracy.

What results did the experimenters report? Twenty-eight studies gave specific attention to the rather general outcome—immediate recall or immediate results. Twenty gave results favoring demonstration method; six favored the individual laboratory method; and two said that there was no difference.

Of the twenty-four studies that gave specific attention to delayed results, ten favored the demonstration method, eleven the individual laboratory method, and three reported no difference.

The interest stimulated in the pupils by the two methods was studied in seven of the enterprises. The majority of the pupils in three favored the demonstration method; and in four favored the individual laboratory method.

All of the studies—fifteen—that gave attention to the time required by each of the two methods reported a saving of time under the demonstration method. The time saved varied from one fifth to one half.

In the one study, that by Goldstein [50] which gave its exclusive attention to finding which of the two methods would better develop laboratory resourcefulness, the findings were distinctly in favor of the individual laboratory method.

Four studies gave specific attention to the method which gave better training in the manipulation of laboratory materials. They all agreed that the individual laboratory method was preferable. It should be pointed out that none of these four assumed that this ability in laboratory manipulation was transferable to other kinds of manipulation.

In a few of the reports slight indications were found that: the pupils who got their science work first by the lecture demonstration method did better work later in their individual laboratory work than those who had individual laboratory work all the time; the demonstration group, when confronted with a new problem with only the apparatus given, was superior on the method of procedure before the experiment was performed and in the test after the experiment had been performed; the lecture demonstration method was better for helping pupils get the reason for following a certain method of procedure; the trait of self-reliance was developed better in students by the individual laboratory method; the trait of attentiveness to the real scientific problem at hand was better developed by the lecture demonstration method; and, under the demonstration method, the subject was more fully covered. Little data, and in some instances none, were presented to support the points in this paragraph but each was mentioned in the conclusions of at least one study. They may be of help in planning future investigations.

The value of the two methods in providing for individual differences has been given attention in four studies. One of these favored the lecture demonstrtaion and three favored the individual laboratory method.

Without presenting much data as evidence several of the studies reported that the lecture demonstration method was less expensive. Van Horne pointed out in his report [43] that the cost for demonstration was about 4.4 per cent of the cost of individual laboratory work. Therefore, Van Horne indicates that if all of the work in his study had been done by demonstration

there would have been a saving of approximately 95.6 per cent on apparatus, materials, gas, and water, and if half of the work had been done by each method the approximate saving would have been 47.8 per cent of the cost of doing all the exercises by individual laboratory work.

Seventeen studies gave attention to one or more of the elements of scientific thinking but no one undertaking made even a slight beginning in the study of this problem in all of its many aspects. The elements of the thinking process that were studied in some of the undertakings were as follows: amount retained in thought work; making proper conclusions to an experiment; application and the interpretation of the results of an experiment; application of principles learned; ability to think in terms of the science subject; ability to follow the steps in scientific procedure; per cent of thought questions answered correctly; method of attack on new problems; scientific attitude; ability to observe; learning a scientific principle; greater carry-over ability; ability to distinguish between fact and superstition; and ability to generalize. Of the seventeen studies that gave attention to some phases of this big and very important problem, twelve favored the demonstration method; four the individual laboratory method; and one came to the conclusion that the pupils could learn to think about equally well by either.

Have the experimenters been reasonably moderate in their claims concerning their findings? While it is true that a few have possibly taken in a little too much territory in their conclusions there are several commendable examples of experimenters who were rather careful to point out the specific inadequacies that existed in their studies, made haste to admit that their undertakings were far from perfect, and cautioned against making sweeping changes in either opinion or laboratory practice because of the findings.

How have the studies, as wholes, been ranked by the critics? Keiser [14] ranked most of these studies by using as criteria the first six of the seven criteria presented in the article by Stuit and Englehart [17]: "specification of experimental factors . . . control of pupil factors . . . control of teacher factors . . . control of general school factors . . . duration of experiment . . . measurement of achievement . . . interpretation of experimental data." On the basis of the first six of these criteria he ranked as of superior value the studies by Horton [36], Van Horne [43], Dyer [34], Carpenter [29], Knox [31], Anibal [28], and Brasure [42]; as of intermediate value, the studies by Kiebler and Woody [26], Nash and Phillips [35], Mayman [19], Cooprider [23, 25], Pruitt [30], Ewing [32], Wilkinson [38], Pugh [39], Walter (first study) [33], Johnson [37], and Cunningham [21, 27]; as of inferior value, the studies by Erickson [40], Boretz [46], Wiley [20], Shore [41], Walter (second study) [45], and Phillips [22]. This covers all of the studies listed in the bibliography except the ones by Hunter, Scott, Payne, Hix, Goldstein, Kahn, De Jarnett, and White; all of which, except the one by Hunter, are later works. The researches by Hunter and Payne have been summarized by Curtis [3, 5]. The low rating given some of the studies may have been due to poor reporting rather than to actual serious defects in the studies themselves. Many of Keiser's ratings are open to serious question and should be checked by other investigators before being accepted.

The superficial judgment of the writer after an examination of the later studies, including the one by Payne, is that none of them would be ranked lower than intermediate on Keiser's standards and possibly some would rank as superior. The later studies are, as a group, uniformly superior to the earlier ones, as a group, in the validity and reliability of the tests, and in the statistical procedures used in handling the data. A few of the earlier studies stand high and one of them—the production by

Horton (actually three studies) [36]—would probably still stand at the top of the list of all the studies in this field of teaching. Horton's work, according to Keiser [14], stands *very* high on "specification of experimental factors," "control of general school factors," and "measurement of achievement." It stands high on "control of pupil factors," "control of teacher factors," and "duration of the experiment."

As the work on this paper has progressed, the writer has discovered that Dr. F. A. Riedel has the data for six unpublished studies on this problem. These studies embrace some six hundred pupils. The subject matter was at the senior high school level in five studies and at the junior high school level in one. The subject matter concerned was general science, physics, and chemistry. Four schools were used and represented eastern and midwestern regions. Four other teachers cooperated with the experimenter in teaching under careful controls. The studies used some superior equating techniques little used in this area of research and also methods of item analysis not heretofore so used. This valuable work should be published.

In making final consideration as to what we should do in practice as a result of knowing about the experimental work on this problem, it is well to remember, of course, that all generalizations made after studying factual data are, to some extent, guesses since a generalization always covers more cases than have been actually examined. Therefore, it is probable that no absolute decision on this general problem for all cases and for all time can ever be made.

It should be assumed that we are going to continue to use both methods and that much more analytical work will be necessary to decide the circumstances under which, and the kind of experiments and exercises with which, each method will be found successful. It is safe to say that in very few studies—probably in none—were all the results uniformly one way or the other for all types of experiments; all types of pupils; and all types of situations. The detailed analysis of individual cases, particularly the analysis of the exceptions to the general findings, is usually lacking and cannot now be made from the reports which have been published.

Little progress was made in the various fields of science—genetics is a good example—so long as attention was centered entirely upon the individuals or things as wholes and to similarities in the results. It was only when attention was given to one factor in the larger configuration at a time, and to the exceptions to the general rule, that real progress was made. Some scientist has said, "Treasure your exceptions." Exceptions "test" the rule rather than "prove" the rule. If in these thirty-seven studies all of the exceptions to, or differences from, the general agreements in the conclusions had been reported in sufficient detail to make a detailed analysis possible now, we would be in a much better position to make helpful and dependable recommendations. Such details should either have been included in the published reports of the studies or they should have been made available for later study by being filed separately in some library.

In the light of the available results of the research done, we are possibly safe in making the following guesses—hypotheses—as to desirable tentative procedures in teaching laboratory work in science:

(1) When ordinary written information tests are to be used in the evaluation of the results of teaching and when all other important factors in the teaching situation are, or can be made, favorable, consider the use of the lecture demonstration method if: the learning involved in connection with the exercises is complicated and difficult; the apparatus used is complicated, difficult to manipulate, or expensive; the apparatus used is sufficiently large to be seen at a distance; the pupils are likely to make mistakes, when working alone, in determining

and interpreting the results after an exercise has been completed; a large amount of subject matter must be covered in a limited time.

(2) When ordinary written information tests are to be used in the evaluation of the teaching results and when all other important factors in the teaching situation are, or can be made, favorable, consider the use of individual laboratory work if: the exercises are short and easy—not complicated as to learning involved or apparatus used; caring for individual differences seems especially desirable; the results can be easily seen and interpreted, by the pupils working alone, after the exercise has been performed. There are some data which indicate that the individual laboratory method may have merit in easy laboratory exercises even though they extend over a rather long time—especially if several observations must be made over a period of days. A few data were found which indicate that girls made a little better use of the individual laboratory method than boys.

(3) Teachers should consider doing a high proportion of the laboratory exercises by the individual laboratory method if one important objective is the development of laboratory skills.

(4) Teachers should consider doing a high proportion of the laboratory work by the individual laboratory method, without specific directions, if one important objective is the development of ability to solve *laboratory* problems.

(5) Teachers should consider doing a high proportion of the laboratory work by the individual laboratory method when one important objective is the development of laboratory resourcefulness.

(6) The use of both methods in a science course will make for greater variety of experiences and therefore increased interest on the part of pupils.

(7) General ability in scientific thinking is so complicated—made up of so many different steps with certain safeguards necessarily surrounding each step [10]—that both methods can probably be used to advantage in its development. Much more analytical work is necessary in order to determine the points in the complicated procedure at which a particular method can make the greater contribution.

Horton [36] states: "In this school—*Seward Park High School, New York*—(italics mine) we shall tentatively adopt the plan of presenting by demonstration the important phenomena and experimentation of which an understanding is required and on which written tests will be based. The laboratory will be used to give practice in handling apparatus and in attempting to solve problems by supervised, but undirected, experimentation." This is an important conclusion coming from the author of one of the superior studies in this field.

Our decision, as to what to do in practice, is made easier when we realize that all of our laboratory teaching need not—should not—be done by one method. It is possible that we may be ignoring a whole continuous series of possibilities between these two extremes. In many cases it may be found best to use both methods in teaching a given topic or idea in science.

Problem solving is a continuous affair. We are in a much better position now to understand the situation and to make better statements of our new problems in the light of the facts which we can bring to bear by selective recall from the work which has already been done. Let us hope that in the future our educational philosophy will lead us to place high value upon experimentation in the field of science teaching and thus encourage the continuance of this type of work.

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CONTRIBUTIONS OF INSTRUCTIONAL FILMS TO THE TEACHING OF HIGH SCHOOL SCIENCE *

I

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THE investigation [1] described in this article represents an effort to determine the extent to which certain selected instructional films in science contribute, particularly by means of the unique and the specialized functions of the medium, to the realization of three of the major objectives of science education in the secondary schools. These three teaching objectives, in terms of which the film contents were analyzed, are:

I. To effect an understanding of scientific principles that will function in the everyday life and activities of the student.
II. To teach the elements of scientific method as skills to be employed in the solution of problems.
III. To develop the scientific attitudes.

EVALUATIVE CRITERIA

In preparation for the projected analysis of contents of some of the best available motion pitcures dealing with aspects of science, a comprehensive list of both the unique and the specialized functions of the motion picture in science was drawn up, based on the published works of several specialists in visual aids and on the investigator's personal experiences in using science films.

The Unique Functions

For the purposes of this study a "unique function" is defined as any educational experience which the motion picture medium can provide but which cannot be provided by any other type of audio-visual aid.

1. Methods or Processes Not Directly Demonstrable

It will be considered that a unique function is served if a scene aids in depicting *Methods or Processes Not Directly Demonstrable* which are of such a nature that a special form of pictorial demonstration is necessary in order to instruct the audience in the method by which men perform the processes involved. These processes must involve human manipulations and activities which for complete demonstration under ordinary circumstances would

a. Extend over too long a period of time for classroom purposes.

* An abstract of an unpublished doctoral dissertation at the University of Michigan, 1945, entitled *Contributions of Instructional Films to the Teaching of High School Science.*

Examples: Methods of breeding hybrid corn.
Methods of preparing spotted-fever vaccine.

b. Involve a complexity of intermediate steps or coördinated acts making special treatment through the motion picture medium necessary in order to show the interrelationship of the various parts to the whole process.

Examples: Mass production methods in the meat-packing industry.
Method of recovering and preserving an archeological or paleontological specimen.
Methods of mining coal.

c. Be impossible because of the student's confinement in time and space.

Examples: Methods of fighting a forest fire.
Method of tapping a rubber tree in the Amazon forest.

2. Action Observable Only Vicariously

It will be considered that a unique function is served if a scene depicts *Action Observable Only Vicariously,* thereby providing such experiences as contribute to the student's awareness or understanding of the scientific subject matter under consideration, but which would be unavailable, vicariously or otherwise, except through the motion picture medium because of

a. The student's confinement in time and space.

Examples: Behavior of beavers in the wild state.
Origin of icebergs at the end of sea-borne glacier.

b. The limitations of the ordinary high school's demonstration facilities.

Examples: Natural phenomena shown by demonstrations involving high-vacuum equipment.
Responses of living visceral organs to various stimuli.

3. Observable Action Simplified Through Animation

It will be considered that a unique function is served if a scene depicts *Observable Action Simplified Through Animation* so as to eliminate intervening or irrelevant details where several interrelated processes or mechanisms are operating at the same time.

Examples: Operation of individual parts of a gasoline engine.
The path of a single organism, such as a gnat, moving rapidly among others of its kind.

4. Unobservable Action Through Animation

It will be considered that a unique function is served if a progressive series of drawings is used to depict *Unobservable Action Through Animation.* (A moving arrow or pointer will not be considered to be an example of animation.)

Examples: Sound wave phenomena.
Heart action, showing the timing of the valves and flow of blood.

5. Slow-Motion Photography

It will be considered that a unique function is served if a scene depicts, through *Slow-Motion Photography,* action which is

a. Unobservable because of the extreme rapidity of the subject's motion.

Examples: Movements of the wing feathers of a bird in horizontal forward flight.
Effect of the impact of a racket upon the shape of a tennis ball.

b. Readily observable but moving too swiftly to permit the observer to gain a clear understanding of the nature of the motion.

Examples: Muscular and skeletal action of a racing greyhound.
The dive of a kingfisher into water.

6. Time-Lapse Photography

It will be considered that a unique function is served if a scene depicts, through *Time-Lapse Photography,* action which is

a. Unobservable because of the slowness and/or remoteness of the moving object.

Examples: Diffusion of a gas throughout another gas.
Movement of Jupiter's satellites during an eight-hour period.

b. Readily observable but moving too

slowly to permit the observer to gain a clear understanding of the nature of the motion.

Examples: Movements accompanying the opening of a flower.
Movements among changing cloud shapes.

7. Simulation of Reality Through the Incorporation of Recorded Sound

It will be considered that a unique function is served if a *Simulation of Reality* is achieved through the incorporation of recorded sound or sound-effects with the film's visual record of the motion in a natural phenomenon, but only when the sound assists in reifying the aspect of science which is the theme of the film.

(Such sound effects as the barking of a dog in a film devoted to the life habits of a snapping turtle, or the whistle of a harbor craft while the use of a sextant is being demonstrated will not be considered as satisfying this criterion of a unique function.)

Examples: Roar and rumble of an active volcano.
Songs and cries of birds.
Note of a tuning fork.

The Specialized Functions

For the purpose of this investigation a "specialized function" of the motion picture medium is defined as any educational experience which may be provided by other visual aids as well as by motion pictures, but to which the motion picture is capable of contributing uniquely because of the technical versatility of the medium.

1. Photomicrography

It will be considered that a specialized function is served, if, through *Photomicrography,* a scene depicts action otherwise unobservable except through use of individual microscopes or microprojection.

Examples: Brownian movements.
Activities of microorganisms.

2. Miniature Photography

It will be considered that a specialized function is served if, through *Miniature Photography,* a scene depicts action otherwise unobservable except through use of moving scale models or other miniature devices.

Examples: Course of erosion of a mountain range into a peneplain. (Simulating reality by photographing changes in a miniature landscape.)
Action of lightning striking a power line. (Simulating reality by photographing an electrical discharge on a miniature landscape with scale-models of buildings, trees, and cattle.)

3. The Human Elements of Science Through the Dramatic Medium of the Motion Picture

It will be considered that a specialized function is served if, through the *Dramatic Medium of the Motion Picture,* the Human Elements of Science are depicted.

(The scene must demonstrate how a scientist attacks and solves his problems. It should show him actually pondering the problem, experimenting, studying results, and drawing conclusions. His use of the scientific method and his possession of the scientific attitudes should be revealed by *pictorial* means, and the depiction should be accompanied, in the narration or titles, by direct verbal reference to method or attitudes.)

Examples: Use of the scientific method.
Scientific attitudes of scientists at work.
Scientific attitudes and habits of mind among laymen.

Expressed thus in the form of criteria by which the contents of films might be analyzed, this list of functions was submitted to four specialists in the teaching of science, who judged each criterion with regard to its appropriateness, practicability of application, objectivity, and comprehensiveness.

Criteria were also prepared for the purpose of indicating as concisely as possible the conditions under which the contents of the films might be considered to be

making a contribution to one of the three major objectives of science teaching. It was decided to credit only those scenes with contributing to one of the three objectives, during the presentation of which a *direct reference* was made in the narration or titles to a principle, an attitude, or an element of scientific method. This was done in order to render the findings more objective, and to eliminate any tendency on the part of the investigator to read into the scenes implications not necessarily justified or subtle ideas which were not likely to be sensed by students viewing the films' contents, and which might not have been in the minds of the men who planned and produced the films.

Contributions of Films to Objectives of Science Teaching

1. It will be considered that an expressed idea in a film makes a contribution to the understanding of a SCIENTIFIC PRINCIPLE if it seems reasonable to infer (that is, if there is defensible evidence to indicate) that the narrator of a sound film or the author of sub-titles in a silent film had a definite scientific principle in mind and was manifestly attempting to teach it. This principle must have photographic or narrated data to illustrate it and must satisfy at least one of the following conditions:

a. The expressed idea must be unmistakably a statement of a scientific principle, satisfying the criteria of a principle, or the narrator must designate it to be a principle. In the latter case, also, it must satisfy the criteria of a principle.

> *Example:* In reflection of light, the angle of incidence is always equal to the angle of reflection.

b. The statement must be capable of being reworded so as to become a scientific principle, without loss of its essential idea.

> *Examples:* But all matter, including gas molecules, attracts other matter.
> Restated, this becomes:
> All bodies of matter attract other bodies of matter with a force which varies directly as the product of their masses and inversely as the square of the distance between them.

c. The statement must employ a technical term or phrase which has direct reference to an accepted scientific principle, or which cannot be understood without an understanding of a scientific principle.

> *Example:* Both the submarine and the dirigible are designed to function through application of Archimedes' Principle.
> The accepted scientific principle referred to here is:
> A body immersed or floating in a fluid is buoyed up by a force equal to the weight of the fluid displaced.

To be considered a scientific principle, a statement

(a) Must be a generalization.
(b) Must be a clear statement of a process or an interaction.
(c) Must be capable of illustration so as to gain conviction.
(d) Must not be a definition.
(e) Must not deal with a specific substance or variety, or with a limited group of substances or species.

2. It will be considered that a contribution to an understanding of An ELEMENT OF SCIENTIFIC METHOD is indicated in a film:

a. If the narrator's script, the actors' dialogue, or the sub-title script includes a direct reference to an Element of Scientific Method.

> *Example:* We must now select the most likely explanation for this reaction and proceed to test that hypothesis experimentally.

b. If the narrator's script, the actor's dialogue, or the sub-title script employs a technical term or phrase which has direct reference to some aspect of the Scientific Method, or which cannot be understood without an understanding of the Elements of Scientific Method.

Example: Observing the flow of urine out of these tubes, we see that the rate of urine formation in the experimental animal on the right is much greater than in the control animal.
In this case the terms "experimental animal" and "control animal" allude to integral concepts in the scientific method.

c. If it seems reasonable to infer (that is, if there is defensible evidence to indicate) that the narrator, actor, or title author had an Element of Scientific Method in mind and was manifestly attempting to convey or demonstrate its meaning.

Example: *Roux* (Pasteur's assistant)—Have we found anything?
Pasteur (Peering through microscope) — Nothing definite. (Sighs) Try Again.
Technician (slumping wearily in his chair) Again?
Pasteur—Yes, again, *again*, and *AGAIN!* Remember our aim: *Find* the microbe; *kill* the microbe!
The Element of Scientific Method exemplified here is "Testing the hypothesis by carrying out the experiment with great care and accuracy."

(For a master list of the elements of scientific method, see the author's articles upon the subject appearing in earlier issues of this magazine.)[2]

3. It will be considered that a contribution to the understanding of a SCIENTIFIC ATTITUDE is indicated in a film:

a. If the narrator's script, the actors' dialogue, or sub-title script includes a direct reference which unmistakably indicates or refers to a Scientific Attitude.

Example: One of the marks of a true scientist is his insatiable curiosity to know more about the world around him.
This statement paraphrases the scientific attitude indicated in:
"A curiosity to know about one's environment."

b. If the narrator's script, actor's dialogue, or the sub-title script calls attention directly to the possession, or the lack, of a specific Scientific Attitude on the part of a character portrayed in the film, or of any other person whose name or personality is involved in the film.

Example: *Colonel Mackey* (to his staff officers in Uganda)—If anyone can, Doctor Bruce will soon get to the bottom of things. He'll not rest until he's learned every fact any of you know about the Sleeping Sickness; and you'd better not palm off any of your fancy theories on him either. He'll check up on every blasted thing you say, and if you've been pulling his leg, he'll be back to throw the lie in your teeth. In a nice way, of course.
Two scientific attitudes are evidenced in these remarks:
"An unwillingness to accept as facts any statements not supported by convincing proof."
"The intention to respect another's point of view."

c. If it seems reasonable to infer (that is, if there is defensible evidence to indicate) that the narrator, actor, or sub-title author had one of the Scientific Attitudes in mind and was manifestly attempting to convey or demonstrate its meaning.

Example: We should be scientific about this, you know.
After all, I've had my fill of superstitions from these natives hereabouts. There's an explanation for what has been happening, if we can only discover what it is.
In this case, the scientific attitude illustrated is:
"The belief that nothing can happen without a cause and that occurrences that seem strange and mysterious can always be explained by natural causes."

(For the master list of scientific attitudes used in this study, see Caldwell and Curtis' latest textbook for general science.)[3]

The foregoing criteria were also validated by the expert judgment of three specialists in the field of the teaching of science to determine whether each criterion was appropriate, practicable for application, objective, and comprehensive.

Attention should be called at this point to the fact that the three categories of functions (unique, specialized, contributions

to objectives) are not mutually exclusive. By way of illustration, one might consider the hypothetical case of a photomicrograph (specialized function) depicting organisms in slow motion (unique function), projected in conjunction with a reference by the narrator to some scientific principle (contribution to a major science objective). On the other hand, one scene might serve two or more unique functions at once, as in the case of a vibrating cello string depicted in slow motion with accompanying sound recording of the musical note thus produced. In the film analyses, scenes were found in several instances to serve at least two functions.

SELECTION OF FILMS FOR ANALYSIS

Although any random selection of science films might have been analyzed for evaluative purposes and the results found to be informative, it was believed that analysis of the *best* films available would be much more revealing of the degree to which classroom films have been developed in their effectiveness for realizing the three teaching objectives mentioned earlier, and for performing the unique and specialized functions of motion pictures. Therefore, two current catalogs [4] of teaching films, *Selected Educational Motion Pictures* (American Council on Education) and *The Film Utilization Guide* (University of Michigan) were examined. Those films which were rated "excellent" in each under the headings of astronomy, biology, chemistry, general science, geology, health and hygiene, physics, and physiology were noted. Thirty-eight such titles were found in the first catalog, twenty-eight of which were also listed in the second catalog. However, four of the latter had been rated as "good" rather than excellent, and as a consequence were excluded from the final selection.

TECHNIQUES OF ANALYSIS

A special form of check-sheet was next devised, upon which each individual scene of an entire film could be indicated as (1) serving certain specified unique or specialized functions of motion pictures (if any), (2) contributing to one or more of the three objectives of science teaching (if any), or (3) serving no such functions or contributing to no such objectives. A trial analysis of one film which was not included in the list selected for study, was then made by the investigator for the purpose of devising and refining a routine of film analysis, gaining facility in its use, and testing the adaptability of the check-sheet for its purpose.

The following routine method of procedure was thus developed in practice and followed consistently throughout the twenty-four film analyses:

1. Prepare a blank check-sheet for use, filling in the film title, date, evaluator's name, etc.
2. Project the entire film once or twice at full projection speed to familiarize oneself with its contents.
3. If no printed transcript of narration is supplied with the film:
   a. Number several sheets of paper in double-column from 1 to 100 or more to provide sufficient scene-numbers
   b. Operate projector at slowest speed *without* sound
   c. Identify each scene with a descriptive word or phrase, and enter these after the proper scene number
   d. Re-project the film, checking for accidental omissions
4. If a printed transcript of narration is supplied with the film:
   a. Operate projector at slow speed, but *with sound*
   b. Enter the number of each scene upon the margin of the transcript opposite the corresponding point in the narration
   c. Re-project the film, checking for accidental omissions
5. Study the film content to identify and tabulate the scenes which serve unique or specialized functions, as described in the criteria set up for the purpose:
   a. Project the film at medium speed *with sound*
   b. Record the function served by the scene (if any) in rough form by abbreviations opposite each scene listed on the transcript or numbered page
   c. Re-project the film, checking for errors or omissions in the record
   d. Transpose the corrected record from

its rough form on the scene lists to the check-sheet

6. Examine the narration and titles to discover, and to copy *verbatim*, the statements in which a scientific principle, an element of scientific method, or a scientific attitude is indicated as described in the criteria set up for that purpose:
   a. Review the entire narration carefully to detect omissions and oversights in the record of analysis
   b. Transpose to the check-sheet the corrected record of the film's contributions to the three teaching objectives
7. Complete the check-sheet record by tallying those scenes which did not serve a unique or a specialized function nor contribute to a major objective.

The reliability of the investigator's judgment in the application of the criteria was checked by means of a second analysis of three different films (14.8 per cent of the total number of scenes) approximately six or seven weeks after the initial analysis. The two analyses were found to be in agreement on the marking of the various scenes in 90.2 per cent of the cases. The validity of the investigator's judgment was also checked by having most of the same three films (12.7 per cent of the total number of scenes) analyzed by three experienced science teachers, who worked as a committee and employed the same techniques of analysis as those used by the investigator. The percentage of agreement between the combined judgments of the committee and those of the investigator was 86.0 per cent. A comparison of the investigator's second (check) analysis, performed from six to seven weeks after the originals, with those of the judges showed a percentage of agreement of 95.5 per cent. These measures were deemed to indicate that the reliability and validity of the investigator's judgment in applying the criteria to the films' contents were sufficiently high to warrant the use of the data gained in the course of this investigation. (Part II will appear in the April issue.)

A STUDY OF THE DEGREE OF RELATIONSHIP EXISTING BETWEEN ABILITY TO RECALL AND TWO MEASURES OF ABILITY TO REASON *

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A MAJOR problem of science education is how to teach and develop the ability to reason. In general, experiments relating to this problem have been inconclusive.

The problem investigated in this study is to determine the relationship between ability to recall facts of science, ability to reason as measured by a particular test, and measured general intelligence of ninth grade general science pupils.

A reasoning test was designed to measure ability to understand relationships between principles and related ideas. This test was made in matching form, each of the 13 sections consisting of lists of seven to ten principles to be matched by lists of forty related ideas. The pupil's problem was to match the ideas with the principles. These tests are now published under the title *An Exercise in Thinking* in the general science textbook *Using Science.* (J. B. Lippincott Company, 1942). There is one test for each of thirteen units of instruction. Development of this test required two years of preliminary experimentation.

In this test it is not necessary for the child to recall any information whatsoever. All principles and related ideas are stated as true, complete sentences. The only problem is to match the items with the

* This is an abstract of a portion of the Ph.D. thesis, *Factors Affecting Learning of General Science,* which is on file at the library of the University of Minnesota. In this abstract bibliography and tests of significance have been omitted for brevity. Part I of this study appeared in the February number.

principles. (The key to this test was made from the combined judgments of three competent science teachers.) The reliability of the 40-item tests averaged .75.

The test of ability to recall information consisted of batteries of completion items covering the same subject matter as was included in the reasoning test.

The general intelligence test is commonly accepted as indicating to some extent the ability of the individual to reason in complex abstract situations.

Four groups of pupils, consisting of 265 pupils in eight classes, were taught according to usual classroom methods. The reasoning test was administered at the time of completion of the unit of study to which it applied. By combining the scores of several unit reasoning tests, the lowest predicted reliabilities of any battery of tests was .923, the highest, .947.

About ten days after the administration of the reasoning test a battery of completion items was administered covering each unit. Scores of several of these tests were also combined to increase their predicted reliabilities which ranged from .910 to .964 for various batteries.

The total number of items in the various batteries ranged from 160 to 210.

Correlations were then calculated for each of the four groups between IQ and Completion scores, IQ and Reasoning scores, and Completion and Reasoning scores. By statistical techniques the correlations were then combined into three correlations, as follows:

TABLE I

CORRELATIONS BETWEEN IQ, COMPLETION TESTS AND REASONING TESTS

	r
IQ—Completion	.585
IQ—Reasoning	.580
Reasoning—Completion	.770

The difference between a correlation of .770 and .585 or .580 is almost certainly statistically significant.

In order to differentiate further between the relationships involved, the method of partial correlation was employed to separate the effect of each variable from the effects of the other two.

TABLE II

PARTIAL CORRELATIONS WITH EACH OF THE THREE VARIABLES HELD CONSTANT IN TURN

Held Constant	*Factors correlated*	*partial r*
Reasoning scores	IQ–Recall scores	.25
Recall scores	IQ–Reasoning scores	.23
IQ	Recall and Reasoning scores	.65

Here are shown much more clearly the true relationships involved. The effect of IQ is shown to be relatively much less than that of the other two factors in knowledge of general science.

It is not possible from correlations to assign cause and effect relationships. It is possible to draw certain very definite conclusions, however.

1. The abilities measured by the mental test and indicated by IQ are not necessarily the major abilities involved in learning general science material tested.

2. Ability to recall information and ability to see relationships between information and related principles are closely correlated.

3. While it is not possible to say that ability to recall information is sufficient to insure understanding of relationships, or vice versa, the two seem to be products of the same learning process and are highly and closely related to each other.

4. It is unlikely that a type of learning which fails to produce the ability to recall facts will be able to produce the ability to see relationships and to understand scientific principles.

SCIENCE READING MATERIALS FOR PUPILS AND TEACHERS *

CLARENCE M. PRUITT
University of Illinois

PISTORIUS, ANNA. What Bird Is It? Wilcox '45, 24 p. $1.00.

QUINN, VERNON. Picture Map Geography of Canada and Alaska. Lippincott '44, 114 p. $2.00.

——— Picture Map Geography of the Pacific Islands. Lippincott '45, 122 p. $2.00.

REED, WILLIAM M. The Sky Is Blue. Harcourt '40, 151 p. $1.50.

ROBINSON, W. W. and IRENE. Big Boy. Macmillan '44, 55 p. $1.50.

SALTEN, FELIX. Bambi. Grosset '40, 293 p. $0.85.

——— Bambi's Children. Grosset '41, 315 p. $0.75.

SMITH, E. BOYD. So Long Ago. Houghton '44, 35 p. $2.00.

SPERRY, ARMSTRONG. The Bamboo; The Coconut. Macmillan '42, 47 p. each. $1.00 each.

WEBBER, IRMA E. Travelers All. W. R. Scott '44, 32 p. $1.25.

WHIPPLE, GERTRUDE. Airplanes at Work. Macmillan '44, 248 p. $1.00.

Writers' Program. Oil and Gas; Story of Coal; Story of Iron and Steel; Snow, Glaciers, and Icebergs; Ladder of Clouds; Trip on Many Waters; Trains Going By; Life in an Ant Hill; A Dream of Stars; Looking at the Moon; Lightning and Electricity; Story of Bees; Book of Stones; Wind, Water and Air; Light of the World; Story of Copper; Story of Glass; Romance of Rubber; Auminum; Cement; Story of Paper; Money; Oysters; Gold; Salmon; Rayon, Nylon and Glass Fibers; Plastics. Whitman '41–'45. $0.50 each.

YALE, JONATHAN. Storybook of Clothing and Shelter. Cardy '39, 272 p. $0.92.

PART IV

COLLEGE TEXTBOOKS

A. Astronomy

FATH, EDWARD A. Elements of Astronomy. McGraw '44, 386 p. $3.00.

FISHER, GEORGE CLYDE and LOCKWOOD, MARIAN. Astronomy. Wiley '40, 205 p. $1.75.

RUSSELL, HENRY NORRIS; DUGAN, R. S. and STEWART, J. Q. Astronomy I: The Solar System. Ginn '45, 470 p. $3.00.

SKILLING, WILLIAM T. and RICHARDSON, R. S. Astronomy. Holt '39, 579 p. $3.00.

B. Biology

BEST, CHARLES H. and TAYLOR, H. B. Living Body. Holt '44, 571 p. $3.90.

KENOGER, LESLIE A. and GODDARD, HENRY A. General Biology. Harper '45, 653 p. $4.50.

MACDOUGAL, MARY and HEGNER, R. W. Biology, the Science of Life. McGraw '43, 912 p. $4.00.

MEREDITH, F. L. The Science of Health. Blakiston '42, 427 p. $2.50.

NEWMAN, HORATIO H. Outlines of General Zoology. Macmillan '43, 661 p. $4.00.

SHULL, AARON F. Principles of Animal Biology. McGraw '41, 417 p. $3.50.

TRANSEAU, EDGAR N. Textbook of Botany. Harper '40, 812 p. $4.00.

WEATHERWAX, PAUL. Plant Biology. Saunders '42, 455 p. $3.25.

C. Chemistry

BRINKLEY, STUART. Introductory General Chemistry. Macmillan '45, 645 p. $4.00.

BRISCOE, HERMAN T. General Chemistry. Houghton '45, 586 p. $3.50.

FRANCIS, CHARLOTTE and MORSE, E. C. Fundamentals of Chemistry and Applications. Macmillan '43, 537 p. $3.50.

HOPKINS, B. SMITH. General Chemistry. Heath '42, 787 p. $3.80.

NAYLOR, NELLIE and LEVESCONTE, A. M. Introductory Chemistry With Household Applications. Appleton '41, 476 p. $3.25.

D. Geography

BENGSTON, NELS and VAN ROYEN, W. Fundamentals of Economic Geography. Prentice '42, 802 p. $4.25.

CASE, E. C. and BERGSMARK, D. R. College Geography. Wiley '40, 767 p. $4.00.

CRESSEY, GEORGE B. Asia's Lands and People. Whittlesey '44, 608 p. $4.50.

DAVIS, D. H. The Earth and Man. Macmillan '42, 675 p. $4.25.

FINCH, VERNON C. and FREWORTHA, G. T. Elements of Geography. McGraw '42, 823 p. $4.00.

PARKINS, A. E. and WHITAKER, J. R. Our Natural Resources and Their Conservation. Wiley '39, 647 p. $4.00.

RENNER, G. T. Global Geography. Crowell '44, 728 p. $3.75.

SMITH, J. RUSSELL and PHILLIPS, M. O. North America. Harcourt '40, 1008 p. $4.75.

TREWORTHA, GLENN. Japan, a Physical, Cultural and Regional Geography. Wisconsin '45, 607 p. $5.00.

WHITBECK, R. H. and WILLIAMS, F. E. Economic Geography of South America. McGraw '44, 469 p. $3.50.

* Continued from February, 1946, SCIENCE EDUCATION.

E. Geology

BLAIR, THOMAS H. Climatology. Prentice '42, 484 p. $5.00.
BRANDS, GEORGE J. Meteorology, A Practical Course in Weather. McGraw '45, 235 p. $2.50.
GEORGE, RUSSEL D. Minerals and Rocks. Appleton '43, 595 p. $6.00.
HINDS, NORMAN. Geomorphology, the Evolution of Landscape. Prentice '43, 595 p. $5.00.
HUSSEY, RUSSELL. Historical Geology, the Geologic History of North America. McGraw '45, 491 p. $3.50.
LOBECK, A. K. Geomorphology, an Introduction to the Study of Landscape. McGraw '39, 731 p. $4.50.
LONGWELL, CHESTER R. ET AL. Outlines of Physical Geography. Wiley '41, 381 p. $2.75.
SCHUCHERT, CHARLES and DUNBAR, C. O. Outlines of Historical Geology. Wiley '41, 291 p. $2.50.
TREWARTHA, GLENN T. An Introduction to Weather and Climate. McGraw '43, 545 p. $4.00.
VONENGELN, O. D. Geomorphology. Macmillan '42, 655 p. $4.50.

F. Physics

AVERY, MARGARET. Household Physics. Macmillan '39, 439 p. $3.50.
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(Concluded in April issue)

BOOK REVIEWS

Andrews, Roy Chapman. *Meet Your Ancestors.* New York: The Viking Press, 1945. 259 p. $3.00.

Competence for reviewing this book would include extensive training in anthropology. Therefore, instead of a critical review we must be content with descriptive statements of what the book contains. Such a decision may be best, anyway, since technically trained anthropologists might give their major attention to interpretations by the author on which they do not agree. Anyway, the author asserts that the book is for the educated general reader rather than for technical students of man's origin.

Here is the story of man's very ancient past; the story of the recurrent appearances of manlike animals here and there on several parts of the earth. Those reappearances range in time from many millions of years up to a few thousand years ago, when surely human beings were earth's inhabitants. The story makes no claim of close continuity throughout the earlier ages. It presents many fragments of pages from the geological book of man's ancestry. In some cases whole pages are reproduced, and sometimes a considerable part of a geological chapter is shown. As recent times are approached there are fewer missing chapters in man's story. Relatively recent geological records are better preserved and more abundant. Recent men left more and better evidences of where and how they lived, thus making it possible to read the story in more connected fashion.

The oldest evidences consist mostly of pieces of bones, or of teeth, usually fossilized and imbedded beneath great quantities of superimposed earth, stone and debris. The uncovering processes of erosion by wind and water expose some of these fragments. These exposed pieces showed modern students where to dig in order to disclose other remnants of evidence. From a fragment that would be meaningless to an ordinary person, our by-no-means ordinary scientists have reconstructed ancient apes and

other animals of the respective periods. It is important to note that these reconstructions have usually been proved essentially correct as new evidences were found from time to time. That fact adds to our confidence in the interpretations. Then occasionally there have been found almost complete skulls, and from these it has been possible to measure brain spaces and thereby to make estimates about intellectual capacities. Other major bones that have been discovered tell of body form, musculature and size. Accumulations of the bones of other animals within and about the cliffs and caves of early homes tell about food animals and how they were used. Preserved charcoal marks the use of fire which began hundreds of thousands of years ago. Cracked bones of hairy elephants, of mastodons, many kinds of deer, and of human skulls, femur and humerus bones, indicate how desirable a food bone marrow was, a delicacy indeed when added to the coarser muscle meat from the huge and strong animals with which early men contended. Food, shelter, individual and group protection against enemies, capture of food or finding acceptable stale food left by stronger animals, were constant problems.

In several cases the entire population of man-like animals disappeared, at least there are no evidences of their continuance. A next stage, different, but more alike than different, in appearance might be found in some other country, leave evidence of its "culture," and disappear after a few tens of thousands of years sojourn. In the case of some man-like animals of later geologic periods, they seem to be offshoots which ended, not parts of the continuing tree. "Some of them never did make progress, for one reason or another. They became only half-human before their line died out. Others had better luck and eventually reached a human status. . . . the progress of the different races was unequal. Some developed into masters of the world at incredible speed. But the Tasmanians who became extinct about 1870 and the existing Australian aborigines lagged far behind. Even though we are using submarines, airplanes, and radios, the primitive Australians are still living in the Stone Age, not much advanced beyond the stage of the Neanderthal Man."

The history indicates that nature was not primarily working toward production of larger and larger man-like animals. Indeed, the largest members of the so-called family tree, some probably attaining four hundred pounds in weight, were the Java and Chinese giants who "lived during the Ice Age or earlier, perhaps more than a million years ago." Peking man, so-called, who lived about 500,000 B.C., was scarcely as large as today's average man. Other types of animals were huge, such as the mammoth, the "Irish" elk, the sloth, the dinosaurs, and many others of different geological periods. Mere size as such seems to have been a losing virtue in the fight to live. "Nature discovered that enormous size was a liability rather than an asset and that it threatened the existence of the type, so she cut it down. Her experiment hadn't worked. But that giants did exist is certain." Of course no one would attempt to apply this tendency to each modern human individual. It does not follow that all big people are on the way out and all small people on the way up. But during the long ages size declined and brain capacity increased and the relationship of these facts means much.

This statement must pass "Java-ape-man," who, if he used stone tools at all, did so meagrely; also "Peking-man" who, a mere half million years ago, used stone tools and who shows "the earliest record of the use of plant food by prehistoric man"; also "Piltdown," "Rhodesian" and "Heidelberg" men, who because of fragmentary records leave much for further research. We then come to "Neanderthal man," of whom there are abundant remains throughout central and western Europe.

Neanderthal man is the "cave man" of modern human caricature. In appearance he wasn't so bad as the long and discontinuous line of ape-like antecedents. And Mr. Andrews says of him: "Even though Neanderthal Man's appearance left much to be desired in the way of pulchritude, and his brain was not of the highest type, nevertheless he was not a fool. He could talk perfectly well and doubtless had a language sufficient for his needs. He could *make* fire; could fashion stones into varied and useful tools; could compete successfully against the world's most fearsome animals such as the hairy mammoth, tiger, cave bear, and woolly rhinoceros; was able to maintain himself throughout the bitter cold of the last glacial period; had learned to bury his dead; and he had developed a social organization and a rudimentary religion. Moreover, he continued to exist and dominate Europe for many thousands of years. No indeed, we need not be ashamed of him even as a direct ancestor."

Neanderthal man was inventive, in meeting his needs. He shaped and finished stone tools, and didn't depend wholly on finding pieces that suited him. He made many kinds of tools for many purposes. He discovered promising caves and built huge stones into partitions, doors and fire places. Such homes were occupied for centuries, possibly by succeeding generations. Statues tell of his art, his hunting, and what is interpreted as his religion. Neanderthal men dominated western Europe for hundreds of thousands of years. The great glacial ages developed steadily and with overwhelming severity. They developed so slowly that any single generation of Neanderthals probably did not know what was taking place. But the steady increase in severity and geographic extent of the killing cold finally left Neanderthals only as part of the records of what used to be.

The book is fascinating in style. It is artful

in what it does not try to tell to the non-technical reader. It is extensively informative but not dogmatic in the story that is told, and it is a graphic story of how a devoted and unusually human scientist lives and works.

Some reader might assert that the scattered geological records do not provide adequate support for the claims regarding man's biological and cultural history. No one claims that the story is complete. No other seemingly valid explanation has been offered as to the meaning of the proved facts. —Otis W. Caldwell

Nelson, George, and Wright, Henry. *Tomorrow's House.* New York: Simon and Schuster, 1945. 214 p. $3.00.

Tomorrow's House tells you how to: (1) plan your new home, (2) remodel your present home, and (3) make the best use of the latest materials, equipment, and appliances. The authors are authorities in the field of modern housing. As Editors of *Architectural Forum* they have worked closely with most major architects in the country and are well informed upon all phases of industrial design and equipment for home building. This book presents the result of their rich and long experience.

This most practical book has many drawings as well as 96 pages of detailed photographs. Various parts of the house are discussed in detail: living rooms, dining and entertainment, kitchens, bathrooms, bedrooms, closets, windows, exteriors, heating, air-conditioning, storage, sound-conditioning, and so on.

Every planner of a new home should have access to this book. Many new ideas are presented and so much practical advice is given. This book should be the initial investment of all the millions of people who will soon build their tomorrow's house. —F. M. D.

Hartnack, Hugo. *Unbidden House Guests.* Tacoma, Washington: Hartnack Publishing Company, 1943. 560 p. $12.00.

This book makes an outstanding contribution to American science. No other book that the reviewer has ever happened across is quite like this one. The book might be described in such terms as: entertaining, whimsical, quaint, amusing. Not a textbook, it contains a world of factual information about more than 1,000 unbidden house guests (pests). Written in an unconventional style, yet refreshingly personal, readers will thoroughly enjoy the reading. Humorous sketches dot the pages and serve as heads and tails to the beginning and ending of chapters. These sketches have to be seen to be appreciated. In addition there are 500 illustrations that elucidate the textual material. Many interesting historical sidelights are included.

The bulk of the book is devoted to the instruction of the reader in the recognition, biology, damaging effects and control of household pests. It is based upon the personal observations of the author and the work of many investigators in this field, primarily German, but also American, English, Swedish, Polish, French and Danish.

Limited in edition to 1,500 copies and as the only book of its kind, every library should have a copy and all biology teachers will be fully repaid by having their own personal copy.

—C. M. P.

Johnstone, B. Kenneth, et al. *Building or Buying a House.* New York: Whittlesey House, McGraw Hill Book Company, 1945. 154 p. $2.75.

No postwar problem is as pressing or more universal than that of housing. Every American is affected one way or another. It is estimated we have a shortage running well over ten million for single-unit dwellings. So building or buying a house assumes tremendous importance for possibly fifty million or more persons. If you are building a house, this book gives you an excellent background for checking materials and better ideas on floor plans. If buying a house, there's a "buyer's check list" which covers many details which should be inspected before purchasing a house. There are many illustrations. This book will save many persons from errors that lead to dissatisfaction and poor investment. —F. M. D.

Woods, Robert S. *The Naturalist's Lexicon.* Pasadena: Abbey Garden Press, 1944. 282 p. $2.75.

The Naturalist's Lexicon is a list of classical Greek and Latin words used or suitable for use in biological nomenclature. An appendix contains a very practical condensed and classified English-Classical supplement. Naturalists will find this an excellent reference for the definitions and correct pronunciations of those names which they so constantly encounter. Personal and place names, names from languages other than Greek or Latin, and words misspelled or wrongly constructed are not given. —G. B. K.

Fraprie, Frank R., and Jordan, Franklin I. (Editors). *The American Annual of Photography 1946.* Volume Sixty. Boston: American Photographic Publishing Co., 1945. 200 p. $2.00.

This is another of the long series of yearbooks on photography always so eagerly awaited by photography enthusiasts everywhere. Again they will not be disappointed. The series of timely, up-to-the-minute articles by authorities on photography include: *Superlative Personalities* by Yousuf Karsh; *Some Byways in Photographic History* by A. E. Marshall; *Curves Can Be Useful* by Allen Greenleaf; *Esthetics in Photography* by Rowena Brownell; *A Preface to Bird Photography* by Eliot Porter; *Winter Magic* by Grant Duggins; *The Photography of*

Trees by Jack Wright; *Glamour Is Expression* by Pasquale D'Angelo; *The Most Civilized Hobby* by Miles Breuer; *The Evolution of the Photographic Objective* by Angelo Montani; *Pictorial Lighting with Flash* by Hubert Luckett; and *The Stereoscope* by Mildred Boyer.

There are seventy black and white illustrations of the best photographs of the year. Brief descriptions of each illustration is given. This also includes film used, camera, lens, time and other pertinent conditions. —G. B. K.

MORGAN, WILLARD D. (Editor). *1001 Ways to Improve Your Photographs.* New York: National Educational Alliance, Inc., 1945. 387 p.

Before the war, photography was America's leading hobby, and in the postwar period should gain a new emphasis as many thousands of camera users in the war will be added to the group. Photography of all kinds has reached new heights of development. Superior cameras and better film has added much to the perfection of technique. Many opportunities will be available both for the amateur and the professional. With such a future for photography, *1001 Ways to Improve Your Photographs* is especially timely. There are over fifty articles on various phases of photography written by many authoritative writers. Many of the articles are illustrated—a great many in color. Altogether this is one of the finest, most practical books in the field. In every sense the book lives up to its subtitle, *The Complete Photographer.* —G. B. K.

MARSHALL, LUCILE ROBERTSON. *Photo Oil Coloring for Fun or Profit.* New York: U. S. Camera Publishing Corporation, 1944. 135 p. $2.00.

Whether for fun or profit or merely interesting reading, this is an excellent book. Described as the only book of its kind published, it has met with great success. By using this book and following the lessons outlined, almost anyone could become at least a fair amateur in a delightful hobby. For those who desire to go beyond this stage, there is a wealth of valuable ideas and suggestions. The discussion on colors (mixing, color harmony, contrasts) is very good. Practically all phases of coloring are discussed: portrait, backgrounds, landscapes, ocean scenes, plants and animals. There are eight pages of full color illustrations. —G. B. K.

VAN CLEEF, EUGENE. *Global Geography for High Schools.* Boston: Allyn and Bacon, 1944. 402 p. $1.48.

This book begins where many books end: Trade Relations. Then follows units on foods, minerals, power and transportation, economic possessions, our American neighbors and the other continents.

The more I examine and read the textbook the better I like it. High school students and teachers should both enjoy and appreciate this excellent textbook. Graphs, maps, charts and photographs have been selected to reenforce the reading material. Economic and commercial aspects have been emphasized. The author is a well known geographer at Ohio State University.

The reviewer fears there is a great lack of properly trained high school geography teachers. Departments of Geography and Schools of Education are making a mistake in decreasing methods courses. We must have better trained geography teachers and training in content alone is insufficient. Knowledge of methods of presenting geography better is essential if pupils are to learn, enjoy and remember the practical and cultural knowledge that especially characterizes geography when properly taught.

—F. M. D.

BLAIR, JULIAN M. *Practical and Theoretical Photography.* New York: Pitman Publishing Corporation, 1945. 243 p. $2.50.

This is the ninth edition of a book that has wide classroom usage. The author is Associate Professor of Physics and Photography at the University of Colorado. Numerous projects are outlined for experimental work. This is a good book for the beginner and for classroom use.

—G. B. K.

MILLER, LLOYD A., AND HALL, AGNES A. Geography Workbook for Van Cleef's Global Geography for High Schools. Boston: Allyn and Bacon, 1944. 240 p.

Pictures—new and different, are found in this work book. Graphs and their explanation, outline of maps and lists of objective test questions are features to help the student to learn worthwhile information about the world in which he lives. This is one of the best work books I have seen in geography. —F. M. D.

BRADLEY, JOHN HODGDON. *World Geography.* Boston: Ginn and Company, 1945. 487 p. $2.48.

The author believes the secondary school is the logical place to attack a serious problem in American education—the geographic illiteracy of the American people. That he proceeds to do in this fine high school textbook. Written in an appealing literary style, so characteristic of his other writings, this book will undoubtedly see wide usage. The maps, charts, graphs, tables and pictures have been carefully selected for their pertinancy and interest-appeal. —F. M. D.

FIFIELD, RUSSELL H., AND PEARCY, G. ETZEL. Geopolitics in Principle and Practice. Boston: Ginn and Company, 1944. 204 p. $2.25.

Part One discusses geopolitics in principle while Part Two discusses geopolitics in practice.

While recognizing the narrow German meaning of geopolitics, this book is mainly concerned with its more liberal interpretation as the geographic study of the state from the point of view of foreign policy.

To explain why Great Powers advance or retrogress, wage war, or pursue any given path, factors of especial geopolitical interest such as location, size, climate and energy, population and manpower, and social and political organizations are featured in the presentation of each power.

The views of Haushofer, Mackinder, Ratzel and Kjellen and others are summarized. German and Japan expansionist designs are carefully documented by direct quotations. The book throws light on the campaigns and strategic phases of World War II. It reviews the general idea of the Arctic as a future Mediterranean; regionalism in internationalism; and so on. Twenty-nine informative maps are included.

—F. M. D.

Brindze, Ruth. *The Gulf Stream.* New York: The VanGuard Press, 1945. 63 p. $2.50.

The Gulf Stream is the mightiest river in the world and it flows in the middle of the ocean. Although it has no banks, seemingly it has flowed in its present course thousands of years. No other stream has so influenced the course of history. Were it not for the Gulf Stream the British Isles and all of northwest Europe would have the iceberg climate of Greenland.

The Gulf Stream helped Columbus discover America and it was studied by Benjamin Franklin. Although much more is known about it now, even today much about it is still mysterious.

This is an unusually attractive book for the teen-age boy or girl. In themselves the beautiful illustrations by Helene Carter would place it above the usual type of book. It is a fine book either for elementary science or geography.

—F. M. D.

Gatti, Attilio. *South of the Sahara.* New York: Robert M. McBride and Company, 1945. 266 p. $3.00.

South of the Sahara is a book of adventures and thrills, reminiscent of books by Martin and Osa Johnson or by Ditmars. Commander Gatti has led ten expeditions to Africa covering a period of twenty-three years, of which fourteen years were spent on African soil.

Fascinating, absorbing are the stories of life in the jungles and among primitive peoples—the gourd-headed tribesmen, the cunning dwarf men, the giant Watussi and the python women of the Zulus. Gatti captured the first okapi of the sunless Ituri forest, half zebra and half giraffe and the first lyre-horned Congo Bongo, half antelope and half zebra. He also captured a pygmy elephant, a giant chimpanzee, and a mammoth twenty-four feet long. Nor will one soon forget the story of the DeWits and the Black Mamba or the author's close call from the cobra.

To those who desire more geographical knowledge of the regions and peoples of the Dark Continent and to others who vicariously enjoy the adventures and thrills of a naturalist's quest, this is recommended as one of the best in recent years. —F. M. D.

Quinn, Vernon. *Picture Map Geography of the Pacific Islands.* Philadelphia: J. B. Lippincott Company, 1945. 122 p. $2.00.

A Vernon Quinn book is always a delight and *Picture Map Geography of the Pacific Islands* is no exception. She knows the secrets of making so inviting its array of facts and so colorful with pictorial maps that every reader longs to visit the lands he is reading about. The maps are in two colors and reveal at a glance the geographic position, relation and character of each island. Boys and girls who have been hearing so much about Iwo Jima, Tarawa, Midway, and the Marianas will enjoy the interestingly written textual material. —F. M. D.

Visher, Stephen Sargent. *Climate of Indiana.* Bloomington, Indiana: S. S. Visher, 1944. 511 p. $4.00.

This is undoubtedly the most comprehensive work yet published on the climate and weather of any state in the Union. Similar studies for other states and sections of the United States are badly needed. The work is based on exhaustive, detailed research and represents a difficult job well done. The author is well known for his previous scholarly publications on weather and climate and the conclusions in this study are applicable to the weather and climatic conditions in adjoining states.

The twenty-seven chapters discuss practically all phases of Indiana's weather. Science and geography teachers of the Mid-West, especially those teaching something about climate and weather will find this a fine reference. The highest temperature on record was 116° F. on July 15, 1936 at Collegeville, near Rensselaer. The record cold temperature was —33° F. at LaFayette on January 2, 1887. The wettest year was 1890 with 49.6 inches with Marengo having 97.4 inches, one of the highest totals ever officially recorded in the interior of the United States. Record rainfall in a day was 10.5 inches at Princeton on August 6, 1905. The driest years were 1930 and 1934 with 29.17 inches (state average 39 inches). Average snowfall is 22 inches, with a record of 107 inches at LaPorte in 1929. —F. M. D.

Humphreys, W. J. *Ways of the Weather.* Lancaster: The Jaques Cattell Press, 1943. 400 p. $4.00.

Doctor Humphreys is probably the best known American weather authority. For thirty years he was Meteorological Physicist of the United States Weather Bureau. All students of weather

recall his *Physics of the Air, Weather Proverbs and Paradoxes, Fogs and Clouds, Rain Making and Other Weather Vagaries,* and *Weather Rambles. Ways of the Weather* is a cultural survey of meteorology that takes its place along with his previous writings.

Knowledge of the weather was especially important during the war and probably more people are interested in it now than at any previous time. This interest will undoubtedly continue and much valuable information will become available. Both professional weathermen and laymen will find this a ready reference. It is quite complete in most respects and has information difficult to find elsewhere. The reviewer wishes he had made available various aspects of world weather records—record rainfalls, snowfalls, cold spells, and so on. —F. M. D.

TANNEHILL, IVAN RAY. *Weather Round the World.* Princeton: Princeton University Press, 1943. 200 p. $2.50.

This book was written for the general reader by one of the world's leading authorities on the weather. The author, formerly chief of the Marine Division of the U. S. Weather Bureau is now chief of the Division of Synoptic Reports and Forecasts.

The illustrations include charts, maps and many remarkable weather photographs. Weather on both land and sea, and around the world is described. Weather in 185 key places is described in a most useful appendix. Written in non-technical language and for the layman, science teachers will not only enjoy reading the book, but will have a practical weather reference book as well. —F. M. D.

HOTCHKISS, WILLIAM O. *Minerals of Might.* Lancaster: The Jaques Cattell Press, 1945. 206 p. $2.50.

Minerals of Might explains natural resources, reviews their wartime and peacetime roles, both past and future, and suggests their role in safeguarding America from the danger of future wars.

The book is written in the form of a discussion, using a popularized dialogue style. The account is most readable, highly informative, and authoritative. The author is President Emeritus of Rensselaer Polytechnic Institute.

By wise restrictions on natural resources to belligerant nations and by providing ourselves with sufficient mineral reserves, the author believes we can safeguard our future. He shows the necessity of America's building up huge stockpiles of minerals and oil to prevent future military aggression by unfriendly nations. No nation can become or remain great without a policy of guarding its mineral wealth.

This is an excellent reference book for the secondary and college physical science instructor, for the layman, and for the science library.

—F. M. D.

ATWOOD, WALLACE W. *The Rocky Mountains.* New York: The Vanguard Press, 1945. 324 p. $3.75.

In this beautifully illustrated volume, Dr. Atwood, President of Clark University, and a foremost authority on the Rocky Mountains, tells the story of our most magnificent mountain area with its many-hued gorges, its snow-capped peaks, its glaciers, and its awe-inspiring scenery. Many incidents such as the story of copper mining in Butte, and the mining of gold near Virginia City, Montana are most interestingly told. The cycle of erosion and other geological developments are described. As to exploring the mountains he says, "The hardships and emergencies test health, strength, self-reliance, character and good fellowship." He stresses preparation as to clothing, equipment of necessities, and to be prepared for changes of weather. "It is not only physical weather, but human temper, that changes," he states. One finishes reading the book wishing that he could have been on some of the many field trips Atwood describes (where he spent more than twenty summers engaged on various geological surveys). Thus is combined not only an interesting geological history of the building of a great mountain range but with it a fascinating personal story of outdoor life in mountain exploration. This is a fine addition to the increasing list of descriptions of America's mountains, rivers, and lakes.

—F. M. D.

GREER, CARLOTTA C. *Your Home and You* and *Foods for Home and School.* Boston: Allyn and Bacon, 1943, 1944. 782 p. and 635 p. $1.92; $1.80.

These are two fine books for anyone to read —boy, girl or adult. Books by Greer are seemingly based on a lot of experience and good common sense. Not only would these books serve excellently as texts in foods and clothing courses, but are recommended for general science, biology, and chemistry classes. There is excellent material on the different kinds of foods and clothing, vitamins, health, and consumer problems.

—F. M. D.

ATHERTON, RALPH. *Principles of Radio for Operators.* New York: The Macmillan Company, 1945. 344 p. $3.75.

Principles of Radio for Operators covers the basic electrical principles and explains fully the working of each part of the radio—vacuum tubes, power supply, receivers, transmitters, and antennas. It is based on the author's extensive experience in training men for communications work in the Armed Forces. It is recommended as a training manual and handbook for radio operators, maintenance men, and for those constructing equipment for receiving, sending, and testing.

—S. M. A.

HOLMBOE, JORGEN, FORSYTHE, GEORGE E., and GUSTIN, WILLIAM. *Dynamic Meteorology.* New York: John Wiley and Sons, Inc., 1945. 278 p. $4.50.

A basic textbook in theoretical meteorology for students preparing for a professional carreer in meteorology. It is quite technical and mathematical. —O. W. B.

HEIMERS, LILI. *Health Education for All Ages.* Upper Montclair, New Jersey: New Jersey State Teachers College, 1944. 36 p. $0.75.

This is a compilation indicating sources of materials—charts, maps, posters, exhibits, films, slides, filmslides, games, pictures, publications and recordings—that may be used in teaching various phases of health education. Excellent for the science teacher. —S. M. A.

RANSOM, SARAH BENT, CHIOCCA, JOHN, AND VAN REEN, ROBERT. *Consumer Chemistry* Upper Montclair, New Jersey: New Jersey State Teachers College, 1945. 36 p. $0.75.

Consumer Chemistry is one of a long series of teacher helps published by The New Jersey State Teachers College. It lists sources of free and inexpensive teaching materials such as charts, films, exhibits, slides, filmslides, pictures, publications and recordings. Recommended for the science and especially the chemistry teacher. —S. M. A.

THE COMMITTEE ON MULTI-SENSORY AIDS OF THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS. *Multi-Sensory Aids in the Teaching of Mathematics.* New York: Bureau of Publications, Teachers College, 1945. 455 p. $2.00.

Mathematics teachers will probably welcome more warmly this Eighteenth Yearbook than almost any of the previous seventeen. It is doubtful if a more pracical suggestive classroom aid for mathematics has been published.

Contents include: Multi-Sensory Aids; Drawing and Design; Demonstrations and Exhibits; Models and Devices; Instruments and Tools; Materials for Construction of Models, History of Models and Devices; and Slides, Films, Three-Dimensional Projection, and Equipment. The appendix gives short descriptions of individual models and devices in the various phases of mathematics.

—C. C. P.

HOOPER, ALFRED. *The River of Mathematics.* New York: Henry Holt and Company, 1945. 401 p. $3.75.

The field of mathematics may be compared to a great river system with its many tributaries. In youth one wades through addition, subtraction, multiplication, division, fractions and decimals. A little later comes algebra, (plane and solid) and trigonometry. Logarithms and the slide rule accompany these. Then comes higher mathematics.

It is along this stream that the author as a pilot takes the reader. He points out points of historical interest and difficulties along the way. With such a pilot, mathematics becomes very interesting and loses many of its difficulties. This is really an excellent attempt in presenting mathematics as a cultural and popular subject. —C. C. P.

BOYER, PHILIP A., CLARK, ARTHUR S., GORDON, HANS C., SCHILLING, JOHN. *Experiences in General Science.* Seventh Year. Chicago: Lyons and Carnahan, 1945. 174 p. $0.68.

Here is the first book in a series of three general science workbooks challenging young people "to learn how to know truthful answers to questions about science." The simplicity of materials and direction are just the right directives for a Junior High School pupil who is experiencing science activities from which he must draw right conclusions. The authors are experienced school men and have organized these nine units in exploring an environment with an introduction and a pretest accompanied by a progress chart. The workbook is accompanied by a set of unit tests.

—G. O.

BOYER, PHILIP A., CLARK, ARTHUR S., GORDON, HANS C., SCHILLING, JOHN. *Experiences in General Science.* Eighth Year. Chicago: Lyons and Carnahan, 1945. 241 p. $0.76.

Continuing experiences in general science, the authors have organized eleven units in the following order: wood and the forests, sound, communication and transportation, solar system, man's work, weather, water, gardening, man's enemy plants and animals, safety and first aid. The units are well organized themselves but the reviewer feels that there is a gap between wood and the forests, sound, water, and gardening, man's enemy plants and animals.

—G. O.

BOYER, PHILIP A., CLARK, ARTHUR S., GORDON, HANS C., SCHILLING, JOHN. *Experiences in General Science.* Ninth Year. Chicago: Lyons and Carnahan, 1945. 228 p. $0.92.

Here experiences in general science are more definitely organized as science experiences and the student's attention is definitely focussed upon the question of what is science and the basic topics of general science are carefully taken care of in nine units. All three books contain page references to all the standard general science texts since 1935 including the 1944 editions of Compton's Encyclopedia and World Book Encyclopedia. A set of unit tests accompany the workbook. —G. O.

BENNETT, H. *The Chemical Formulary.* Vol. VII. Brooklyn: Chemical Publishing Company, Inc., 1945. 474 p. $6.00.

Another volume of the Chemical Formulary, that timely collection of valuable, practical com-

mercial formulae and recipes for making thousands of products in many fields of industry from whipped cream and weed killers and chigger bite treatment to abrasives, chile concarne and drug products. The formularly is up to the minute in that additional new formulae have been gathered to supplement the other six volumes. Some 606 sellers of chemicals and supplies are listed as well as an alphabetical list of chemicals so numbered as to correspond to the list of suppliers. Teachers of chemistry and home economics teachers will welcome the formularly and its information for its practical interest and mature users of the formulae will continue to find the book valuable for compounding their products.
—G. O.

FULLER, ROBERT W., BROWNLEE, RAYMOND B., BAKER, D. LEE. *New Laboratory Experiments in Physics.* Boston: Allyn and Bacon, 1945. 302 p. $0.75.

This laboratory manual is written to accompany "Elements of Physics." The authors have included a wide range of experiments to fit laboratory equipment available and the time limitations of most first courses in physics. Thirty five experiments are suggested for laboratory instruction in those fundamentals necessary to a study of physics; additional experiments are recommended for superior students and sixty-six more experiments are included in their suggestions where double laboratory periods still prevail. A list of experiments with special references to girls and their practical relationship to life is included also. The experiments are so written that if a double period is not available, the experiments can be done in single periods. Careful attention has been given to the procedures of the experiments and to the questions in the discussions. Space is provided for the necessary drawings. Unit tests accompany the manual. —G. O.

HENDERSON, W. D. *Physics Guide and Laboratory Exercises.* Chicago: Lyons and Carnahan, 1945. 360 p. $1.08.

Physics Guide was prepared with two objectives in view. The first is to help the student to help himself and the second to help the teacher by relieving him of much routine work. The manual is organized on the unit plan grouped around the usual areas of physics. References are given to thirteen commonly used texts. Self-tests are included for the student and final tests for each unit and final semester examinations are furnished separately. The thought-provoking introductions to the problems are excellently done and the study outlines with the "high points" in the lesson certainly should focus attention upon the important phases of the physics lesson and help to produce better learners. There is good consumer approach to many of the physics problems and opportunities to do individual and group projects. The author exhibits unusual ability to state physical principles in terms of practical problems and questions to arouse the student's interest. —G. O.

ALLEN, JOHN STUART. *Astronomy: What Everyone Should Know.* New York: The Bobbs-Merrill Company, 1945. 199 p. $2.50.

A clear, nontechnical treatment of the facts and principles of astronomy for the layman. Interestingly written and illustrated.
—O. W. B.

WOLFE, BERNARD. *Plastics.* Indianapolis: The Bobbs-Merrill Company, 1945. 189 p. $2.50.

Nothing seems to be impossible in the plastic world. The reader of this book learns how plastics are made, who makes them, why they are hard to get, and the prospects for the plastic future. An industry which began less than a century ago by providing a substitute for scarce materials has come into its own.

The author discusses the various processes, ingredients, and machinery which enable modern miracles to take place: wood becomes safety glass, paint, textiles, jewelry, cellophane; coal is developed into electrical material, lucite, bathtubs; soy beans become automobiles which will not splinter nor break; cottage cheese is knitted into a sweater.

The making of laminated plastics is one of the industry's most startling developments. Out of them boats, chairs, and other large objects may be built. Before hardening, laminated plastics may be cut, tooled, or molded, but after hardening they are found to be as strong as steel.

This book is well illustrated, is packed with interesting information, and is written so that all may understand. It is an excellent book for the science section of a high school library.
—R. V. M.

SEYMOUR, FLORA WARREN. *Bird Girl: Sacagawea.* Indianapolis: The Bobbs-Merrill Company, 1945. 187 p. $1.50.

One of America's heroines is Sacagawea and many monuments have been built in her honor. She accompanied Lewis and Clark on their exploration trip in 1805 and they credited much of its success to her. Daughter of the Shoshoni, captured by the Minitaries, she became the wife of a French trapper. The author, Mrs. Seymour, has written one of the finest stories for boys and girls—even adults will thoroughly enjoy the story of the *Bird Girl: Sacagawea.*
—G. E. D.

YATES, RAYMOND F. *Atom Smashers.* New York: Didier, 1945. 182 p. $2.00

This is a story of the *Atom Smashers* from the days of the early Greek philosophers who speculated about the structure of matter, to the scientists of today who developed cyclotrons and atomic bombs.

The author demonstrates his ability to explain a highly technical subject on the level of the

average reader. Many drawings and photographs are used to make the contents clearer to the reader. The graphic description of the development of the atomic bomb is written so the average high school student will enjoy it.

High school physics and chemistry instructors will be very interested in this book. It will help answer many questions on the atomic bomb.

—R. V. M.

CARLISLE, NORMAN, CLEVELAND, REGINALD, AND WOOD, JONATHAN. *The Modern Wonder Book of the Air.* Philadelphia: The John C. Winston Company, 1945. 316 p. $2.50.

The authors of *The Modern Wonder Book of the Air* are members of Aviation Research Associates and their exceptional background and experience is evidenced throughout the book. Technical enough, yet it is so simply written that the teen age boy or girl can readily understand what is discussed. The profusion of photographs and illustrations make this an unusually attractive book. Every boy and girl with any interest in aviation whatever will be delighted to read this book. And they will surely know a lot about the "inside" of aviation when they have finished.

—S. M. A.

PERRY, JOSEPHINE. *The Chemical Industry, The Glass Industry, The Electrical Industry, Fish Production, The Coal Industry, The Cotton Industry, The Steel Industry, Forestry and Lumbering, and Milk Production.* New York: Longmans, Green and Company, 1940–1945. 125–128 p. each. $1.75.

This is the excellent *America at Work* series. The last two titles have Celeste Slauson as co-author. These books are epecially fine reference and supplementary readers for the upper grades and junior high school pupil. Chemistry students can profitably read most or all of them. Science libraries should have the entire set as an easy, readable reference. Teachers of elementary science will find a wealth of valuable and interesting information. There are many excellent photographs. Every effort has been made to have the textual material scientifically accurate. Material in some titles are necessarily less complete than others. In these cases an attempt was made to select the more important representative aspects. —S. M. A.

FREEMAN, MAE AND IRA. *Fun with Chemistry.* New York: Random House, 1944. 59 p. $1.25.

Fun with Chemistry is a fine book for the upper intermediate grade or junior high school boy or girl. A series of easy, safe experiments are carefully explained and illustrated with excellent photographs. All the experiments can be performed at home at very little cost. This is about as elementary as chemistry experiments can be made and is therefore a fine beginning book for any boy or girl who has a desire to do some experiments himself. The experiments are not "messy" and this will appeal to the mother and *aid the boy.*

—G. B. K.

YATES, RAYMOND F. *Fun with Electronics.* New York: D. Appleton-Century Company, 1945. 159 p. $2.75.

Electronics has been called the science of today and tomorrow. And in recent years and during the war so much has been heard about the role of electrons in shapening present day science.

Not many writers have Mr. Yates ability to take a technical subject and write it appealingly for boys and girls. But in *Fun with Electronics* he does just that. Many experiments with electricity are described and illustrated with 78 diagrams and 30 photographs. This is a fine book for the science library, the science club, the science teacher, and any teen-ager interested in electricity.

—G. B. K.

MCKENNY, MARGARET AND JOHNSTON, EDITH F. *A Book of Wayside Fruits.* New York: Macmillan Company, 1945. 78 p. $2.50.

Another attractive book by the authors of *A Book of Garden Flowers* and *A Book of Wild Flowers.* The colored and black and white illustrations by Mrs. Johnston are about as attractive as one will happen across. Fruits are divided into early summer fruits, mid-summer fruits and autumn fruits. Many of these are quite familiar, but there are less familiar ones, too.

General science and biology teachers will find the book an excellent reference and useful for supplementary outside class reading. High school libraries will find it a valuable addition of permanent value.

—G. E. D.

ANONYMOUS. *"Boy's Fun Book of Things to Make and Do."* New York: Foremost Books, 1945. 192 p. $1.49.

This is almost a *must* book for the science club sponsor and for the science teacher. It describes 216 ways to have fun and 470 how-to-do-it illustrations. There is something about almost anything a boy might wish to do—mostly some phase of science. The table of contents indicate what a valuable teaching aid it really is: (1) How to make model planes that really fly, (2) How to mystify your friends with simple magic, (3) How to build a speedy soap-box racer, (4) How to have fun with paper and card-board, (5) How to handle a rope, (6) How to send secret messages to your friends, (7) How to have fun with hobbies, (8) Science stunts at home, (8) Fun with electricity, (9) Mystifying puzzles and brain-teasers, (10) Unusual radios you can build, (11) Games you can play outdoors or in your own backyard, and (13) It's fun to go camping. —S. M. A.

BRUERE, MARTHA BENSLEY. *Your Forests.* Philadelphia: J. B. Lippincott Company, 1945. 159 p. $2.50.

Some interesting chapters in this book are *What Your Forests Are, From Logs to Plastics, Food, Pleasure and Knowledge, Everybody Loses When the Forest Burns,* and *Traveling Trees.* There are 56 photographs. Nearly one-third of our country is forest land and twenty-eight percent of this belongs to State and Federal Governments. In its many stories of foresters and their varied work, this is a valuable career book for boys, suggesting many aspects of forestry as a man's job, though men and women alike are concerned with conservation of our forests for use and enjoyment.

There is information about many new uses and treatments of wood. —F. M. D.

VANDEVENTER, W. C. *Course Outline for General Biology.* Columbia, Missouri: W. C. VanDeventer, Stephens College, 1944. 262 p. $2.75.

Once in a great while one chances across a course that seems to live up to one's expectation of what a course should be. Survey courses in biology, for the most part, usually fall just a little (often more than this) short of their idealistic intentions. Far too many times they consist of a slice of botany, a slice of zoology, and a similar bit of physiology. Each part is a distinctly separate entity. Not so with this course offered at Stephens College. Based on the needs and the interests of students, the approach and viewpoint is definitely functional. It is the type of course that every survey course in biology should be. This holds true for the textual material and unquestionably carries over into the presentation. Except for the opening unit which is somewhat technical (The Infusion Microcosm), the units emphasize problems in human relationships such as: (1) Housing, (2) Food, (3) Personal Appearance, (4) Communication, (5) Reproduction, (6) Health and Disease, (7) Behavior, (8) Human Relationships, (9) Utilization of Energy, (10) Man and the Universe, and (11) Relating to Man's Thinking.

The syllabus material is intentionally presented in mimeographed form. A mimeographed copy of the reorganized course is now available.

—C. M. P.

JAKEMAN, M. WELLS. *The Origins and History of the Mayas: Part I, Introductory Investigations.* Los Angeles: Research Publishing Company, 1945. 203 p. $3.00.

It was once thought that the Aztecs and Incas and their shadowy forerunners, the Toltecs, represented the most ancient civilizations in the New World. But at the beginning of the nineteenth century it became apparent from certain ruins in Mexico and Central America that a much earlier civilization had existed here. Since that time much research and archeological work has been done among the ruins of the ancient cities of the people we call Mayas but whose own name for themselves has never been determined. Some headway has been made in reading the hieroglyphics of the Mayas and in arriving at the solution of the problem of their origins. Abundant archeological data and somewhat extensive documentary evidence is now available in solving this problem.

The ancient calendar or chronological system of the Mayas must be regarded as one of the great scientific achievements of antiquity. In fact the Maya astronomers seem to have succeeded at an early date in measuring the length of the solar year with greater accuracy even than that attained by our modern Gregorian calendar.

Some of the ancient Mayan cities are judged to have been centers of population ranging well into the hundreds of thousands. All together they probably comprised the world's most flourishing civilization of their time.

Part I of this study indicates much careful and exhaustive research into this problem of the history of the Mayas and as such may be said to make one of the greatest contributions yet made in an archeological field that has proven so baffling. —C. M. P.

MATHEWS, ARTHUR GUY. *Take It Easy.* New York: Sheridan House, 1945. 239 p. $2.98.

The subtitle of this treatise is *The Art of Conquering Your Nerves.* Many of our physical ills have an emotional base and as such can often be helped more by a psychiatrist than by a physician. The fact is that all good physicians are good psychologists, too. Mental ills are just as real as physical ills and should be so understood. *Take It Easy* tries to get at the emotional bases of "nerves" or neuroses and cites many case histories and simple exercises to eliminate or avoid such mental disturbances or frustrations. The book is worth reading even if you have no frustrations or "nerves" of any kind; if you do, it may be just the book to get you "back on the beam."

—G. E. D.

GOOD, CARTER V. *Dictionary of Education.* New York: McGraw-Hill Book Company, 1945. 495 p. $4.00.

The *Dictionary of Education* was prepared under the auspices of Phi Delta Kappa. Approximately 16,000 terms in the literature of education are defined. Both technical and professional terms are used. Altogether it forms a monumental work and as someone has said, "with the publication of the Dictionary of Education the science of education becomes of age." It is a work that has long been needed and "is the first instrument of the profession as a whole which is dedicated to exactness of words and the artistry of precision." It is scholarly, accurate, and thorough.

—S. M. A.

FINE, BENJAMIN. *Democratic Education.* New York: Thomas Y. Crowell Company, 1945. 251 p. $2.50.

Benjamin Fine, the author, is Education Editor of the New York Times. Dr. Fine's survey of teaching in American History made us realize how little the average college student really knows about history. Likewise in this book he surveys higher education and higher institutions as to how nearly they are ready for education in the post-war era. He sees some colleges aligning themselves as the democratic institution that believes most of our high school graduates can profit by higher education and should be permitted to pursue it until they demonstrate otherwise. Both academic and vocational education will be emphasized in this democratic institution. The University of Minnesota seems to be of this viewpoint. Then there are those schools which may be too aristocratic to allow anyone to enter unless they have certain social standing and importance—catering only to the rich and sophisticated.

The author believes American colleges should be "democratic" in the sense envisioned by Franklin, Jefferson, Mann, and Dewey.

Altogether the book is a penetrating analysis of the struggle going on between two philosophies of education as to what American colleges ought to be. There is an excellent analysis of the problems of the returning veteran and the place and functions of the general college.

—C. M. P.

BIRREN, FABER. *Selling with Color.* New York: McGraw-Hill Book Company, 1945. 244 p. $2.50.

In their buying people are very much influenced by color whether it is a dress, suit, automobile, a blanket, or a package of groceries. Advertisers, merchants, and manufacturers are keenly aware of this and make attempts to increase their sales accordingly. *Selling with Color* is a practical book that presents facts and sets forth principles that have the support of extensive research and sales records. Much of this evidence is presented. Along with these facts are presented the theories and psychology of color. People do prefer certain colors. Colors of envelopes and paper do make a difference. This is a fine reference for courses in consumer problems, advertising, home economics, and the color phases of science courses. —C. M. P.

LUHR, OVERTON. *Physics Tells Why.* Lancaster: The Jaques Cattell Press, 1943. 318 p. $3.50.

Physics Tells Why is one of the successful attempts to present physics as a cultural subject. A person reading and understanding most of the things the author presents in this book would have a fairly good elementary understanding of physics.

One chapter in the book has been rarely found in physics courses during the last four decades or so. It is the chapter, "About the Weather." At the end of the textual material is a series of questions which the reader may use to test themselves. *Physics Tells Why* is a fine reference book for the high school science teacher, the high school physics student, the college physical science survey course, and the general lay reader. —C. M. P.

BUNDY, ROSS. *The Romance of Existence.* New York: Pitman Publishing Corporation, 1944. 188 p. $2.00.

The Romance of Existence is a cultural, somewhat philosophical contemplation of existence. It is a story of our world—its geology and natural history—and the elemental forces which surround it and influence life. Life on other planets; development of life on this planet, evolution, thought transference, destiny of the earth, and immortality are a few of the ideas discussed. The literary style is one of the chief characteristics, in many ways adding much to the interest and appeal of the reader, reminding one somewhat of the famous Steele's Fourteen Week series of an earlier day. —C. M. P.

BRUNNER, EDMUND DE S., SANDERS, IRWIN T. AND ENSMINGER, DOUGLAS. *Farmers of the World: The Development of Agricultural Extension.* New York: Columbia University Press, 1945. 208 p. $2.50.

"The primary aim of this book is to discuss the most effective general approach which a government or a private agency can use in helping rural people solve their everyday problems. This approach is commonly called *Extension.* Specific ways and means are discussed in this treatise." The various contributors have had experience in extension in various countries of the world and in these experiences there is a surprising similarity. —F. M. D.

CLARK, WILLIAM H. *Farms and Farmers.* Boston: L. C. Page and Company, 1945. 346 p. $3.75.

Nearly thirty million citizens are established on American farms. Farms and farmers were never more important than they are today. For that matter they have always been important. American prosperity has always been measured by farmer prosperity. Truly farmers are the backbone of the country.

Curiously enough the fascinating story of American farming has never been adequately told. *Farms and Farmers* as the story of American agriculture attempts to do this and does it remarkably well. It is a story that has long needed telling. *Farms and Farmers* is a most interesting book to read—a fine supplementary book for the science pupil and teacher (especially biology and agriculture) as well as the layman. There are many illustrations from photographs, drawings and old prints, thorough documentation, chronology, and bibliography. Thus the

work is based upon much research and involved the elimination of much interesting material. Surely more of this material should be made more readily accessible in a treatise of two or three volumes in length. —C. M. P.

COLLINGWOOD, R. G. *The Idea of Nature.* New York: Oxford University Press, 1945. 183 p. $4.00.

In *The Idea of Nature* the late R. G. Collingwood traces the history of the idea of nature from the early Greeks through the Renaissance to the present day. He reaches no final conclusion and at the end he is forced to say "That is as far as science has reached." He believed that no one can understand natural science unless he understands history and "no one can answer the question what nature is unless he knows what history is." The book is not highly technical but is definitely for the college science teacher or philosopher and the trained scientist.

—S. M. A.

RUSSELL, HENRY NORRIS, DUGAN, RAYMOND SMITH, AND STEWART, JOHN QUINCY. *Asronomy I The Solar System.* Boston: Ginn and Company, 1945. 470 p. $3.00.

This is a complete revision of a work first published in 1926. Astronomy has made great advances since that time and this revision comes at a most opportune time. The completion of Volume II will be most welcome. *The Solar System* is not only an excellent textbook but a fine reference for the elementary science, general science and college physical science survey course teachers.

—S. M. A.

BOK, BART J. AND BOK, PRISCILLA F. *The Milky Way.* Philadelphia: The Blakiston Company, 1945. 224 p. $2.25.

This seond edition brings up to date the recent advances made in the exploration of the Milky Way. The material is presented in semi-popular form giving the reader an accurate account of our present knowledge and some insight into methods of obtaining this information. There are 100 illustrations including an insert of a compositive photograph of the northern and southern Milky Way. The photographs made with the new Schmidt cameras bring out many new details.

This is an excellent reference book for the science library and for all science teachers but especially teachers of physical science survey courses. Laymen with a keen interest in astronomy will not find the reading too difficult.

—G. E. D.

ABSTRACTS

SCHNEIDER, JOSEPH. "On the Social and Moral Implications of Science." *The Scientific Monthly* 61:353–358. November, 1945.

Until well in the nineteenth century men believed the world was an order and that the discovery of this order would make men happier, better or both. But now some question that scientific knowledge has enriched the social and moral life one iota.

Winning power over nature has not effected the good life. The tools of science are powerless to decide the good life. The results yielded up by science are empirical and relational. But man as a scientist cannot decide which is the better social and moral order. If we wish to call a given social and moral order more desirable than another, the tools of science can conceivably provide the means for its attainment.

CARLSON, A. J. "The Science Core in Liberal Education." *The Scientific Monthly* 61:379–381. November, 1945.

Disagreeing with the viewpoint expressed by Dr. Fred B. Millett in his recent book, "The Rebirth of Liberal Education" and concurred in by President Hutchins that "science and the scientific method are the most dangerous foes of the humanities in our liberal education program," the author maintains the exact opposite is true. He says, "the goal of the natural sciences is the understanding of man and the universe."

The minimum core of science in a liberal education should include: "(a) a mastery of the scientific method, the principles of experimentation and controls in experience; (b) the fundamentals of human biology in health and disease; and (c) the fundamental forces and processes in the universe. The general science courses for all college freshmen has gotten results in the University of Chicago. But the same plan, with different teachers, has failed in some colleges. The teacher must be convinced that the experiment is worth trying."

EMME, EARLE E. "Implications of Superstitious Beliefs Among College Students." *The Phi Delta Kappan* 27:16–17. October, 1945.

Some thirty-seven research studies reveal that: (1) People become less superstitious as they grow older; (2) Women are more superstitious than men; (3) Specific instruction reduces superstitions; (4) People become less superstitious as they advance in educational attainment; (5) The sources of superstitious beliefs are ranked in the following order with strong emphasis upon the first: home, chums, courses, and reading; (6) Intelligence (college students of low intelligence are more likely to be superstitious); and (7) Mild superstitious beliefs. Many college students were found to have a few mild beliefs just for the fun of it.

COHEN, BERNARD. "American Physicists at War: from the Revolution to the World Wars." *American Journal of Physics* 13:223–235. August, 1945.

The Civil War marked the first coordinated effort of American scientists to serve their country in war time. Yet even during the Revolution General Washington had four French military engineers on his general staff. The Smithsonian Institution formed during the Civil War and under the guidance of Joseph Henry performed a very valuable service.

CONDON, EDWARD U. "Atomic Bombs and the Future." *Journal of Chemical Education* 22:481–488. October, 1945.

The atomic bomb was the result of the researches of many workers in numerous countries, but the basic discovery was made in Germany in 1938. The United States produced the bomb in three years at a cost of approximately two billion dollars. Future costs may be very much less and a large part of the plants that were built are probably obsolete now. In the future we must make certain that atomic power is used only for peaceful purposes but we must continue at the same time fundamental research in atomic physics.

OTT, GEORGE W. "The Geographic Ascendency of the Americas." *The Journal of Geography* 44:273–279. October, 1945.

The Americas have at their disposal a steadily mounting preponderance of the world's economic and military power. Of the eight most valuable minerals the percentages produced in the Americas is: Coal 40 per cent; Petroleum 75 per cent; Pig Iron 60 per cent; Natural Gas 98 per cent; Copper 70 per cent; Zinc 57 per cent; Lead 60 per cent; and Sulfur 65 per cent. Of the other 20 minerals vital to industrial predominance, the Americas produce 50 per cent or more of eleven.

With three-tenths of the land area of the globe, the Americas contain about half of the cultivable land. The Americas lead in production of such vital materials as cotton, corn, bananas, coffee, flaxseed, beef and wheat. They possess over two-thirds of the world's merchant shipping. In the Americas, the United States possesses approximately half of the population and 90 per cent of the indutrial and military power.

STRAIN, WARREN. "The Florida Phosphate Industry." *The Journal of Geography* 44:257–264 October, 1945.

Of the 11,000,000 tons of commercial fertilizers used by American farmers in 1944, approximately one-half was made up of phosphate. Florida accounts for nearly three-fourths of this phosphate. Mining is by open-pit hydraulic-mining method, and 97 per cent is from phosphate pebbles varying in size from fine sand to

nodules the size of a man's fist, embedded in a matrix of clay and sand. It is estimated that Florida reserves will last 4,000 years at the present rate of consumption.

DAVIS, WATSON. "Loran" Guides Pilots. *Science News Letter* 48:275–276. November 3, 1945.

A vast network using radio, not radar, covers three-tenths of the earth's surface. It can locate pilot of plane or ship within a mile or two regardless of weather. First put into operation in 1942, it will have very important peace-time uses.

ORE, OYSTEIN. "Our Everyday Reckonings." *The Scientific Monthly* 61:372–378. November, 1945.

Although our system of weights, measures, money and so on seem clumsy and illogical, there is less chance today of our adopting the metric system than in the past. There is a much greater probability of the World Calendar replacing the Gregorian.

ANONYMOUS. "Counter-Radar Devices." *Science News Letter* 48:355–356. December 8, 1945.

A handful of aluminum foil was scattered in the air by approaching planes to blot out radar echo. This destroyed the effectiveness of German and Japanese radar. Approximately 20,000,000 pounds of aluminum was so used in Europe alone. A bundle of 6,000 strips weighing six ounces, dropped from a plane looked to radar like three heavy bombers. Electronic jammers operating on the principle of radio interference had extensive use. A powerful land-based jammer in England blinded German planes following English bombers homeward.

ANONYMOUS. "Bacteria and Petroleum." *Science News Letter* 48:342. December 1, 1945.

Bacteria may have had a number of important roles in the formation and development of the earth's petroleum deposits. Most geologists now believe that petroleum formation started with the dead plant or animal materials. Bacteria may have started the change into hydrocarbons. There is much evidence that certain bacteria aided in forming oil pools and that other bacteria destroyed many vast pools. Bacteria that feed on oil are now being used to detect oil pools (because they accumulate in the soils above).

ANONYMOUS. "Ghost Army Victories." *Science News Letter* 48:374–375. December 15, 1945.

An American "ghost army" that never fought but won decisive victories by fooling the enemy. It consisted of inflated pneumatic tubes and painted fabrics whose true nature of decoy trucks and ships were undetectable within a few hundred yards.

ANONYMOUS. "612 Repels Mosquitoes." *Science News Letter* 48:375. December 15, 1945.

A new repellant known as "612" repels the yellow fever mosquito for as much as twenty hours and also is effective against chiggers.

ANONYMOUS. "Locates Storm Areas." *Science News Letter* 48:372. December 15, 1945.

A static detection finder, using a cathode tube similar to radar and perpendicular receiving loops, locates storms within a radius of 2,000 miles. It was used successfully in the Pacific War theater.

GRANT, CHAPMAN. "A Biological Explanation of the Carolina Bays." *The Scientific Monthly* 61:443–450. December, 1945.

Various explanations have been advanced to explain the origin of the Carolina bays which vary in length from a few yards to over a mile. Among these have been (1) terrestrial: volcanism, wind, ocean currents, wind-caused currents, lakes, sink holes, drowned bays, segmented lagoons, etc., and (2) extraterrestrial: bombardment by meteorites or the head of the comet.

The author advances the theory that they are of biological origin, having been produced by schools of fishes similar to the salmon or menhaden. The author takes each of the late Douglas Johnson's twenty-nine features of the craters and shows how they are best explained by his biological theory.

SYMPOSIUM. "Science Review of the Year." *Science News Letter* 48:386–399. December 22, 1945.

An unusually important summary of the greatest year that science has ever had. Watson Davis, director of Science Service, lists as the ten most important advances science made in 1945: (1) The atomic bomb and the practical release of nuclear energy of potential industrial use; (2) Discovery and verification of the trans-uranium chemical elements 93, 94, 95 and 96, and the large-scale production of 94, plutonium, for use in the atomic bomb; (3) Use of the antibiotic, streptomycin, for the treatment of many diseases, especially those not cured by the sulfa drugs and penicillin; (4) Development of the proximity fuze; (5) Development and use of loran, which allows determination of exact position at sea and in the air through use of exactly timed radio signals; (6) Use of psychological warfare methods in hastening the Japanese unconditional surrender; (7) Development and use of BAL, a kind of alcohol, for the treatment of arsenic and mercury poisoning; (8) Development and use of the chemicals, ANTU and 1080, for killing rats and other rodents; (9) Successful transplantation of hearts in warm-blooded animals; (10) Steps taken in Congress for the establishment of a National Science Foundation.